MEETING OF JOIDES DOWNHOLE MEASUREMENTS PANEL

Texas A & M University
College Station

6-8 February 1991

EXECUTIVE SUMMARY



1. An important focus of this meeting was the question of borehole stability in tectonically active regions. Other important aspects were a briefing session with ODP/TAMU engineers, a review of the wireline packer and alternative technologies for downhole fluid sampling, joint discussions with ODP/TAMU systems engineers to review progress towards the shipboard integration of core and log data, development of the FY92 logging programme, and the status of high-temperature downhole-measurement technology.

2. Panel was informed by ODP/TAMU engineers of initial plans to progress the reaming option for drilling loggable holes at Diamond Coring System (DCS) sites. During Leg 142 it is planned to attempt a 7-inch hole using a diamond core barrel (DCB). This is the first step up the learning curve of reaming a 7-inch hole from a 4-hole. The Engineers report that if a 7-inch hole cannot be drilled with the DCB, reaming to this size will not be a viable option. However, reaming to smaller diameters might be achievable.

3. The Panel reaffirms its commitment to the scientific objective of obtaining uncontaminated fluid samples downhole. At present, ODP does not have a functional wireline sampler through which this objective can be achieved.

4. The two basic issues governing fluid sampling are the engineering of the tool and the scientific integrity of the sample. Both of these aspects should be examined by a specialist working group or workshop with a view to identifying the best available options for downhole fluid sampling in ODP-type situations. No new tool developments should take place until these issues have been resolved.

**[DMP Recommendation 91/1 : to PCOM and JOI]**

5. The Geoprops Probe should be subjected to further land tests after the remaining necessary modifications have been made. Subject to a satisfactory performance in those tests, the Geoprops Probe should be tested at sea by ODP at least two legs prior to its proposed scientific deployment, in order to allow adequate time for any residual modifications to be made.

**[DMP Recommendation 91/2 : to Geoprops Proponent and ODP/TAMU]**

6. The Panel congratulates the ODP/TAMU Technical Service Group on the excellent progress towards the shipboard computer-based integration of core and log data.

7. The growing demands on systems staff arising from shipboard computer-based data integration is making it necessary to have more computer technical support on board ship, at least for the time being. The level of this support should be sufficient to ensure that the data integration goals can be achieved.

**[DMP Recommendation 91/3 : to ODP/TAMU]**

8. A high-spectral resolution geochemical tool should be run in Hole 504B during Leg 140, in addition to the standard GLT. This will allow a comparison of sodium-iodide and high-resolution detectors as well as providing important new elemental flux data. The high-spectral-resolution tool should be subjected to land tests and full performance evaluation prior to deployment.

**[DMP Recommendation 91/4 : to LDGO and Leg 140 Co-chiefs]**

9. In addition to standard logs and targeted check-shot VSP, an enhanced-resolution geochemical log should be run in selected holes during Legs 143 and 144, provided that earlier deployments are considered successful. Such a tool could greatly enhance the geochemical characterisation of drillhole sites, especially with regard to trace elements.

**[DMP Recommendation 91/5 : to LDGO, Atolls & Guyots DPG, and Legs 143 & 144 Co-chiefs]**

10. In addition to standard logs, high-resolution magnetometer and susceptibility tools should be run in selected holes of the North Pacific Transect (Leg 145).

**[DMP Recommendation 91/6 : to LDGO and Leg 145 Co-chiefs]**

11. Since Re-entry Hole 801C is located just three days out of Guam, the port call between Legs 143 and 144, this hole should be re-entered and the previously aborted programme of downhole measurements carried out. This exercise should be regarded as an addendum to the FY92 ODP programme. This is an important issue because Hole 801C penetrates very old oceanic crust and there is no provision for ODP to drill crust of similar age in the future.

**[DMP Recommendation 91/7 : to PCOM]**

12. The following options should be considered to enhance the prospects of borehole logging in accretionary complexes.

    (i) Case off the upper portions of unstable holes either with a full re-entry system or using the drill-in-casing system (DIC) with or without a mini-cone.

    (ii) Drill offset dedicated holes for logging where cored holes become unstable; the dedicated holes can be drilled quickly to reduce exposure of the formation to seawater.

    (iii) Log deep holes in several stages: during XCB drilling, this should not require additional pipetrips; during RCB drilling, additional trips may be needed.

(iv) After drilling and coring, flush logging holes clean and then fill with heavy mud, probably weighted with barite, with a weight of at least 12 lbs/gallon. In many cases, mud density approaching the formation density (19-22 lbs/gallon) will be more appropriate. Facilities and time on the ship will need to be available for mixing and delivering such a heavy mud. Flushing holes clean before using heavy mud may require pumping large volumes of fluid, particularly in cases where hole erosion is severe. The presence of barite mud will probably preclude lithodensity and photo-electric measurements (and will thus also reduce the quality of geochemical log measurements), but should have little impact on sonic, neutron porosity, natural gamma, resistivity and FMS logs. Borehole fluid sampling, packer measurements and BHTV runs will be compromised through the use of heavy mud (requiring that these measurements be made before heavy mud is pumped or in separate holes), but temperature logs may be improved if borehole convection is reduced.

(v) The need for heavy mud for each proposed hole should be identified and discussed by the co-chiefs, logging scientists, LDGO BRG representative and operations superintendent during the precruise meeting.

(vi) As with drilling muds, add chemical inhibitors and viscosity enhancers to logging muds when necessary.

(vii) Recognise that the sidewall-entry-sub (SES) is not designed to allow logging in unstable holes; it is best used in good holes with minor bridging problems.

(viii) Deploy short logging strings where these are significantly easier to run than long strings.

(ix) The time needed to make special preparations for logging must be included in time estimates for all legs during which these preparations are expected to be necessary.

**[DMP Recommendation 91/8 : to LDGO, ODP/TAMU and Co-chiefs]**

13. Because expensive ship time has been wasted and tools have been lost while trying to log unstable holes, at least a major portion of a future engineering leg should be devoted to evaluating borehole stability strategies in an accretionary setting, in preparation for upcoming scientific programmes.

**[DMP Recommendation 91/9 : to PCOM and ODP/TAMU]**

14. For high-temperature downhole measurements, the aim is to seek redundancy in both temperature measurements and fluid sampling. It two tools perform well, they can both be admitted for ODP deployment. Opportunities for interprogramme collaboration should continue to be explored.

15. Panel supports the proposal for a bromide tracer experiment in Hole 504B during and after Leg 137 as an important contribution to understanding fluid exchange with the upper basement.

16. The next meeting of the JOIDES Downhole Measurements Panel is scheduled to take place at the Lamont-Doherty Geological Observatory, Palisades, New York, during the period 4-6 June 1991. This meeting will include a joint session with the JOIDES Sedimentary and Geochemical Processes Panel and will encompass a tour of LDGO Borehole Research Group facilities.

PAUL F. WORTHINGTON
18 February 1991

MEETING OF JOIDES DOWNHOLE MEASUREMENTS PANEL

**Texas A & M University**
**College Station**

**6-8 February 1991**

**MINUTES**

Present

| | | |
|---|---|---|
| Chairman: | | P F Worthington (UK) |
| Members: | | B Carson (USA) |
| | | J Gieskes (USA) |
| | | D Karig (USA) |
| | | P Lysne (USA) |
| | | R Morin (USA) |
| | | C Sondergeld (USA) |
| | | R Wilkens (USA) |
| | | H Crocker (Canada/Australia) |
| | | J-P Foucher (France) |
| | | H Villinger (FRG) |
| Liaisons: | | K Becker (PCOM) |
| | | A Fisher (ODP/TAMU) |
| | | R Jarrard (LDGO) |
| | | J McClain (LITHP) |
| | | J Mienert (SGPP) |
| *Guests | | R N Anderson (LDGO) |
| | ** | L Bernstein (ODP/TAMU) |
| | * | E Davis (Geological Survey of Canada) |
| | * | J Firth (ODP/TAMU) |
| | | G Foss (ODP/TAMU) |
| | ** | J Foster (ODP/TAMU) |
| | | T Francis (ODP/TAMU) |
| | | R Grout (ODP/TAMU) |
| | | B Harding (ODP/TAMU) |
| | | D Huey (ODP/TAMU) |
| | * | M Langseth (LDGO) |
| | * | R Lawrence (ODP/TAMU) |
| | ** | M Mefferd (ODP/TAMU) |
| | ** | R Merrill (ODP/TAMY |
| | ** | B Meyer (ODP/TAMU) |
| | * | D Moos (Stanford Univ.) |
| | * | R Pace (NL Baroid) |
| | *** | E Payne (representing BP Exploration) |
| | | T Pettigrew (ODP/TAMU) |

*** A Pierce (representing BP Exploration)
E Scholz (LDGO)
M Storms (ODP/TAMU)
* M von Breymann (ODP/TAMU)

Apologies: X Golovchenko (LDGO)
M Hutchinson (USA)
K Moran (SMP)
T Pyle (JOI)
O Stephansson (ESF)
M Williams (USA)
M Yamano (Japan)

* attendance for agenda item 15 only.
** attendance for agenda item 13 only.
*** attendance for agenda items 9-11 only.

**1. Welcome and Introductory Remarks**

The meeting was called to order at 0850 hours on Wednesday 6 February 1991. This was the first DMP meeting of the year. Carson and Villinger were attending for the last time as panel members. Becker was attending for the first time as PCOM Liaison. An important focus of the meeting was the question of borehole stability in tectonically active regions. Other important features of this meeting were a briefing session with ODP/TAMU engineers, a review of the wireline packer and alternative technologies for downhole fluid sampling, joint discussions with ODP/TAMU systems engineers to review progress towards the shipboard integration of core and log data, development of the FY92 logging programme, and the status of high-temperature downhole-measurement technology.

**Review of Agenda and Revisions**

Borehole Seals would be reported under Tool Monitor Reports as Agenda Item 7(vi). Gieskes had proposed an additional agenda item concerning a tracer experiment at Hole 504B (Item 20). Discussion of the FY92 Logging Programme (Agenda Item 14) would be preceded by a brief review for FY91. The meeting would run to 1830 hours on 7 February and conclude at 1330 hours on 8 February 1991. With these modifications the precirculated agenda was adopted as a working document for the meeting.

**2. Minutes of Previous DMP Meeting, Townsville, Queensland, 11-13 October 1990**

The minutes were adopted without modification.

**Matters Arising**

(i) Publication in the JOIDES Journal of approved guidelines for the deployment of third party tools.

The Chairman had been informed by the JOIDES office that these were to appear in the next issue of the JOIDES Journal.

(ii) Logging characteristics of gas hydrates.

The Chairman will not be making a presentation at this meeting. Instead it will be made to the SGPP working subgroup on gas hydrates at their meeting in early March.

**[ACTION:WORTHINGTON]**

3. **Chairman's Annual Report**

The Chairman reviewed the highlights of 1990 and the forward projections for 1991 as presented to the annual meeting of PCOM and Panel Chairs in Kailua-Kona, Hawaii, during the period 27-30 November 1990.

There had been three DMP meetings during 1990, in College Station (January), Seattle (June) and Townsville, Queensland (October). The last meeting encompassed a joint session with the Shipboard Measurements Panel (SMP); this joint meeting had been preceded by a facilitation Workshop in Miami (August).

Three meetings are planned for 1991, in College Station (February), Palisades, New York (June), and Victoria, BC (September). The Palisades meeting, to be held at the Lamont-Doherty Geological Observatory, is proposed to encompass a joint meeting with the Sedimentary and Geochemical Processes Panel (SGPP). The Victoria meeting is proposed as a joint meeting with SMP.

The highlights of 1990 had been:

- a greater use of log data by the ODP and general marine science communities;
- the proven contribution of the formation microscanner;
- the development of a strategy for the shipboard integration of core and log data;
- development and deployment of the strengthened side-entry-sub;
- renewal-targeted presentations by the Panel Chairman to the National Science Board (USA), NERC (UK), and Australian Government Ministers and Science Planners;
- publication in Japanese of the multi-authored paper "Scientific applications of downhole measurements in the ocean basins", originally published in "Basin Research".

The disappointments of 1990 had been:

- hole stability problems in Nankai-type situations;
- the performance of the wireline packer during deployment at sea;

- the erratic facilitation of panel initiatives, particularly with regard to the holding of the ad hoc workshop on core-log integration.

The DMP strategy for 1991 comprises several elements.

Wireline Packer: a detailed performance evaluation, a design post-mortem, and a review of alternative technologies.

High-temperature Logging: targeted on temperature, pressure, borehole fluid sampling and formation resistivity, for slimhole deployment; a wider range of measurements may be possible at conventional hole diameters; a back-to-back study of leasable tools; aim to keep options open at present.

Sediment Magnetometer: validate accuracy and precision, link to core, assess performance reliability, reversals, time logging (with Milankovitch).

Geoprops Probe: needs functioning Motor-driven Core Barrel : trials, performance evaluation, deployment at sea.

Shipboard Integration of Core and Log Data : strategy/schedule for implementation, working group to monitor progress, review with SMP in September 1991.

Third Party Tools : publish guidelines, monitor compliance, loss control.

Publications : invited paper by Panel Chairman in "Reviews of Geophysics" on the status of exploration well logging; ODP will be strongly promoted; publication date estimated as December 1991. Paper in Geotimes by LDGO highlighting the growth in usage of ODP logging data within the earth-science community; suggested for submittal in mid-1991.

Specific recommendations not covered by the above include the FMS to be adopted as a standard logging tool, and the need to deploy the Diamond Coring System (DCS) under the direction of an experienced diamond core driller.

Two causes for concern were emphasized.

(1) Hole stability in accretionary wedges. There is a need to identify problems and remedies. A working group meeting has been proposed for 6 February 1991, as part of this DMP meeting.

(2) During 1991 there may be a need to propose ad hoc meetings in order to progress (i) high-temperature logging and (ii) wireline packer and alternatives. It might be beneficial to delegate these to subgroups. The system should have the flexibility to allow this to happen where justified.

## 4. PCOM Report

Becker reported on the November 1990 meeting of PCOM (held with Panel Chairs present) with particular regard to the PCOM response to DMP Recommendations 90/16-90/25.

| Rec. No. | Description | PCOM Response |
|---|---|---|
| 90/16 | Shipboard test of LAST II | Not discussed |
| 90/17 | Contractor's evaluation of wireline packer | Not discussed: already done by LDGO |
| 90/18 | Post-cruise processing of BHTV | Not discussed: to be pursued by LDGO |
| 90/19 | High-temperature logging | Covered during JOI report to PCOM: progressing |
| 90/20 | DCS drilling | Flagged as important by PCOM: identified for later discussion but not revisited: ODP/TAMU aware |
| 90/21 | Cement-bond log in Oahu test hole | For Co-Chiefs' attention |
| 90/22 | Run FMS in 504B during Leg 137 | Not accepted per se: if 504B is saved, run FMS during Leg 140: if 504B not cleared, FMS is highest priority log for Leg 137 (see below) |
| 90/23 | FMS to be a standard logging tool | Accepted |
| 90/24 | Working group on borehole stability in accretionary wedges | Accepted |
| 90/25 | Joint DMP/SMP specification of user needs for shipboard core-log data integration | Accepted with proviso that DMP and SMP maintain close liaison during the implementation phase |

There was some discussion of DMP Recommendation 90/21. Foss pointed out that the long spaced sonic (LSS) is scheduled for the Oahu test hole; yet, the fulfilment of the recommendation requires the borehole-compensated sonic (BHC). The logging contractor undertook to investigate this matter, noting that the BHC is, in any event, present on the ship all the time as a redundant tool.

**[ACTION:LDGO LIAISON]**

Becker reported that a primary thrust of the November 1990 PCOM meeting had been to decide the drilling programme for FY92. The outcome resulted in a two-month extension of the Pacific phase of drilling with the following leg structure.

| | | | | | |
|---|---|---|---|---|---|
| Leg | 140 | 504B or Hess Deep | Leg | 144 | Atolls and Guyots II |
| | 141 | Chile Triple Junction | | 145 | North Pacific Transect |
| | 142 | EPR Engineering Leg | | 146 | Cascadia |
| | 143 | Atolls and Guyots I | | 147 | Hess Deep or EPR |

Science that depends on the Diamond Coring System (DCS) could not be accommodated, i.e. Sedimented Ridges II or EPR Science. Other candidates not scheduled were Peru Gas Hydrates and Bering Sea. If Leg 137 is successful in cleaning out Hole 504B, Leg 140 will be a science leg at this site.

PCOM approved the concept of add-on science for FY92. This should be in accord with the theme of the cruise. An advertisement has been placed in EOS to solicit proposals.

The Chairman reported on some discussion at the PCOM meeting concerning panel recommendations. Although panels exist to advise PCOM, and all their advice should be channelled through PCOM, it was recognised that many DMP recommendations are actually targeted at others, e.g. LDGO, ODP/TAMU and JOI. In many cases, DMP recommendations had actually been implemented before they were presented to PCOM. It was therefore deemed appropriate for the Panel to state at whom a recommendation is directed, so that action can be taken as soon as possible. In such cases it will be presumed that the recommendation is being made through PCOM. In general, PCOM would expect to discuss recommendations concerned with scientific planning matters but not those that address the details of technical support. The Chairman commented that as far as DMP is concerned, this represents a most appropriate shift of emphasis.

## 5. JOI Report

Pyle had conveyed his apologies for the meeting : therefore, no JOI report was received.

## 6. Liaison Reports

### (i) Lithosphere Panel

McClain reported that ODP is now drilling holes very relevant to LITHP aims. In the short term, these include a full suite of logs in 504B, including FMS, packer, flowmeter, etc. In the longer term, targets are EPR bare rock sites, Hess Deep and Sedimented Ridges II. Deep crustal drilling is a long-term goal : LITHP has proposed an interim programme of drilling holes with 2-3 km penetration. Offset drilling is relevant to the Hess Deep : a proposal to set up a working group to report on this technique has seen a postponement by PCOM. High-temperature logging is the most important common interest between LITHP and DMP. The joint DMP-LITHP meeting in Windischeschenbach in October 1989 had been highly successful. Another joint meeting was desirable and at the earliest possible date. However, logistic considerations suggest the first part of 1992 as the earliest feasible opportunity.

### (ii) Sedimentary and Geochemical Processes Panel

Mienert reported that SGPP had ranked Cascadia, Chile Triple Junction and Peru Margin Gas Hydrates as their three highest priorities for FY92. The last of these has not been scheduled; the other two are programmed.

The main SGPP problems are borehole stability and the drilling and logging of gas hydrates. A key question is the relationship of methane content to the bottom simulating reflector (BSR) : this question might be answered by comparing the characteristics of areas with and without the BSR.

The technology needed to address these goals comprises the sampling of liquid and gas, measurement of physical properties (Vp, $\phi$, etc.), downhole temperature logs, and hole sealing.

In Cascadia it is proposed to use Geoprops, Pressure Core Barrel, borehole sealing, and a full suite of logs. We need to have a contingency if Nankai-type conditions preclude operations. SGPP needs to know which downhole tools have a high expectation of working at Cascadia.

In June, there will be a joint meeting of DMP and SGPP. Four possible agenda items were proposed.

(1) Probability of successful deployment of different downhole tools at Cascadia.

(2) Accuracy of geochemical logs.

(3) Logs in gas hydrates.

(4) How to make maximum use of sealed boreholes. How to keep samples at in-situ temperature and pressure.

The Chairman confirmed that he would be attending the next SGPP meeting at College Station in early March and would be making a presentation on the logging characteristics of gas hydrates.

(iii) <u>**KTB**</u>

Villinger reported that the main hole has reached a depth of 1143 m with 1500 m penetration estimated for the end of February. Current diameter is 17.5 inches. Drilling is comparatively slow because the Vertical Drilling System is being used and this requires great precision. The last logs were run at 763 m. These included a prototype of the Formation Micro Imager (FMI), a more sophisticated development of the FMS. It is proving difficult to correlate the pilot hole with the present hole, even though these are only 200 m apart.

KTB is looking at the question of high-temperature logging cable. Approaches have been made to JAPEX and to BICC (UK). The specifications include : 300°C; 150 MPa; 4000 m length; connects to standard cable; minimum 4 conductors but 7 conductors preferred. Key issues are the maximum delivery length, armouring, and the splicing technique. Lysne noted that there already exists 7-conductor teflon cable rated to 300°C.

There is to be a national KTB meeting in March. Lysne observed that an ODP-KTB workshop is needed to explore collaboration on high-temperature work. He noted that the US DoE and KTB are entering into some kind of mutually supportive agreement. There is also an NSF-KTB agreement to allow experiments in the KTB hole by US scientists. Panel noted that Villinger is to be replaced as FRG representative on DMP by Hans Draxler of KTB. It would be appropriate to explore collaborative possibilities at the next DMP meeting.

## 7. Tool Monitor Reports

### (i) Geoprops Probe

Karig reported that a test had been carried out in a mock-up borehole at ODP/TAMU in December 1990. The hole was about 75 ft deep and used a full-scale BHA. The test was quite successful. The slug valve needs to be re-examined : there is believed to be a problem with sticky 'O' rings. There may also be a problem with packer inflation, since their maximum rated pressure might not be adequate to guarantee a perfect seal.

The Geoprops Probe needs a bench test to evaluate slug valve performance and then a further land test. Other technical needs are spare parts and a shipping container. Residual funds might cover some of these requirements but not all. At present there is no formal technical support for the tool, which is a third party tool. The system is nowhere near ready to go to sea. There is no plan for a second land test as yet.

The Geoprops Probe is needed for the Cascadia Leg. It should not be deployed at sea for the first time during Cascadia. Therefore an earlier target leg for initial shipboard deployment will need to be identified. Pettigrew, who had been involved in the Geoprops land test, confirmed that TAM had designed the tool well and that it works well considering this was a first attempt. It does, however, need more land testing. As regards shipboard testing, Pettigrew is tentatively scheduled to sail on Legs 136 and 139, and this might be relevant to future planning.

The Chairman commented that Geoprops should not be viewed in isolation. There are other impacting factors. The first of these is the Motor-driven Core Barrel (MDCB) without which Geoprops cannot be deployed. The second is the status of the Wireline Packer which also aims to sample fluids. The feasibility and relative importance of Geoprops can only be evaluated when the Panel has been informed of progress in these two areas, scheduled for reporting under Agenda Items 9 and 10, respectively, and when due consideration has been given to possible alternative technologies under Agenda Item 11. Further discussion of Geoprops was therefore deferred until later.

### (ii) BGR Borehole Magnetometer

Villinger reported that work is continuing on the dewaring with Leg 140 as the ODP deployment target.

### (iii) LAST

Moran had conveyed apologies for the meeting and no written report had been received.

### (iv) Flowmeter Tool

Morin reported that the tool had been completed one month ago and satisfactorily bench tested. It had been shipped to LDGO for land testing in the LDGO test hole. Becker and Morin were to visit LDGO and would familiarise themselves with MASSCOMP. Subject to satisfactory land testing, the tool would be shipped to Hawaii to join Leg 137 for the return to Hole 504B.

The Chairman asked that special care be taken to comply with the guidelines for the deployment of third party tools. If we are to expect others to comply, it is important that we set an example ourselves.

(v) Japanese Downhole Magnetometer

Yamano tabled the following report *in absentia*.

Some of the specifications for the new Japanese downhole magnetometer have been changed. The tool would measure the three components of the geomagnetic field and the temperature inside the pressure case every one second. Magnetic susceptibility measurement will not be made because of technical difficulties in developing sensors. The two measurement ranges and resolutions are c.64000 nT and ± 2 nT or c.32000 nT and ±1 nT, and can be selected by a command from the ship through the cable.

The development schedule has also been changed. The tool will be completed by the end of August 1991, and tested in Japan during September. As a result, it cannot be proposed for use in Hole 504B on Leg 140. The first target will be Legs 143 and 144 (Atolls and Guyots). Although no magnetometer measurement is included in the FY92 downhole measurements prospectus, it is important to investigate the formation history of guyots and seamounts through logging the geomagnetic field. A proposal for using the Japanese downhole magnetometer on these legs will be presented in the detailed planning group meeting.

[N.B. DMP has not recommended downhole magnetometry during Legs 143 and 144 - see Item 14]

(vi) Borehole Seals

Instrumented borehole (re-entry cone) seals are being developed for initial deployment during Sedimented Ridges I (Leg 139) after testing operations during Leg 136. An NSF grant makes provision for six seals to be built in conjunction with Canada and the ODP. One has been built to date : it is to be shipped to Hawaii today (7 February 1991). This is not yet plumbed for sampling.

Becker is responsible for downhole instrumentation comprising thermistors on a downhole cable and a sampling tube. Davis is responsible for data loggers. Carson is responsible for the hydraulic coupling to a submersible (or ROV). A submersible can interrogate the data logger.

The deployment of the six seals is as follows:

Sedimented Ridges I (Leg 139 : July 1991) - 3 seals.
Cascadia (Leg 146 : September 1992) - 2 seals.
EPR - 1 seal.

It should be noted that the deployment of the seal requires a re-entry cone and a second casing string. This may impact on the time available for coring. However, SGPP view is that the fluid story is more important than core recovery at Sedimented Ridges I. A submersible is to be employed two weeks or so after Leg 139 to interrogate initially the three data loggers.

Becker reported that there has been a problem with costing. This is not a standard third-party tool and there is an ODP/TAMU budget element. The current ODP/TAMU budget does not encompass three seals for this fiscal year. Now that we have a more realistic estimate of costs, NSF should be re-approached for top-up funds.

## 8. Logging Contractor's Report

Anderson reported that the logging programme for Leg 134 had been carried out almost to the letter. This leg saw the first running of the German digital BHTV : no images are available yet in hard copy.

Leg 134 also saw the first ODP deployment of the French susceptibility and magnetometer tools. The magnetometer has a (high) resolution of ± 0.1 nT. Attempts are in progress to invert magnetic data in terms of time (reversals). The current view is that long wavelength diurnal variations do not require correction through surface magnetometry. However, these data do exist and they can be incorporated into the inversion process if necessary. The results will be reported at the next meeting. Schlumberger currently has three of these tools, one in the North Sea, one in Indonesia, and the slimhole version used on Leg 134.

The present leg is Leg 135. Here the FMS is being run in very shallow holes with a full logging suite in deeper holes. This indicates that the rule for logging holes deeper than 400 m, which was established to ensure that logs were run, might now be approaching redundancy. Unlike the early days, there is now a widespread appreciation of the importance of the logging product. The digital televiewer on board ship is no longer functioning : it has been broken during Leg 135.

Anderson commented on the need to extend the scope of geochemical logging. The present Schlumberger GLT has a low spectral resolution NaI detector. The Schlumberger prototype enhanced resolution tool (ERT), a cryogenic tool with a high spectral resolution and a claimed capability for diagnosing 28 elements, has now been abandoned. It is to be replaced by a new tool with a non-cryogenic composite crystal that is being developed by Schlumberger, but it will be some time before this becomes commercially available. The immediate prospect is an ARCO enhanced resolution tool which is potentially available to ODP. A possibility is that ODP might be able to run the ARCO tool with Schlumberger support. The prospects for enhanced-resolution geochemical logging (in ODP) therefore seem to be most favourable.

The Schlumberger MAXIS system, a super version of the present Cyber Service Unit (CSU), was scheduled to be installed onboard ship during the San Diego port call in July 1991. However, Schlumberger have requested a delay because of software difficulties. A possibility for installation is the second San Diego port call in November 1992. The CSU will be retained for a two-leg overlap with MAXIS to provide cover in the event of any teething problems.

Jarrard presented data that confirmed FMS repeatability. Two separate passes with the same pad orientation produced almost identical images. There is always a possibility that the pad orientations will not be the same on a repeat pass. In these cases, the cover of the borehole wall will be greater than with one logging run. The comment was made that shipboard data processing workloads might preclude repeat FMS runs on a routine basis. The Chairman suggested that Jarrard's repeatability demonstration ought to form the subject of an early publication.

Anderson reported that because of the large growth in requests for ODP data, the LDGO FY92 budget provides for four new technical posts. There are $140 000 allocated to high-temperature tool development in FY91 and a further $140 000 are earmarked for FY92. Schlumberger have announced increases in the engineer day rate (5%), the tool lease rate (4%), and the FMS day rate (60%). A decision is needed on whether to proceed with the Wireline Packer since this has implications for the budget.

NSF are funding Dave Goldberg of LDGO to convert the ARCO shear-source tool for ODP use.

## 9. TAMU Engineering Briefing

Storms reported on the status of the Diamond Coring System (DCS) Phase 2. This has a planned 4500 m total depth capability. Minor improvements are needed to the platform and the DCS itself, e.g. to the secondary heave compensator and the winch control. The re-entry funnel has been redesigned to expose more of the upward-facing surface of the guidebase. Various sea-floor spudding options are being evaluated for hard-rock sites.

A meeting between JOI, NSF and ODP/TAMU was held in December 1990. About $1.6 million is needed to complete the DCS Phase 2. This includes a feasibility study for DCS Phase 3. Indications are that the full sum will be forthcoming. The potential cost of the Phase 3 system is $3 million. This funding will not be made available in one fiscal year but perhaps over two years. Thus the DCS Phase 3 may not be ready before Leg 147 at EPR.

During Leg 142, also at EPR, it is planned to attempt a 7-inch hole using a diamond core barrel (DCB). This is the first step up the learning curve of our ability to ream a 7-inch hole from a 4-inch hole. It a 7-inch hole cannot be drilled with the DCB, reaming to this size will not be a viable option. If it can be drilled, a caliper log will be needed to investigate hole quality. A point to note is that even if the 7-inch hole is unsuccessful, other diameters (e.g. 5.125 inches) might be achievable.

Pettigrew reported on a new go-devil to be run with the straddle packer for flowmeter operation. The packer and the wireline have to be run concurrently. This requires that the drilling and wireline heave compensators be run at the same time. The go-devil pressures up and sets the packer. When depressured, the go-devil decouples from the wireline and is subsequently recovered.

The Pressure Core Sampler is on its way back from the ship. It needs re-fitting with high-temperature (125°C) seals. This is the prototype phase-1 tool : no action is being taken at present concerning a phase-2 tool.

Huey reported on the Vibra Percussive Core Barrel. This was deployed during Leg 133 after favourable land tests. However, the shipboard performance did not match the earlier tests on land.

The Motor-driven Core Barrel (MDCB), a new version of the Navidrill, was deployed during Leg 134 and is currently out on Leg 135. It has worked in 4 out of 5 runs. In the four "successful" runs, the best recovery was 1.85 m out of 3.5 m (instead of the target 4.5 m penetration). In essence, the MDCB is working erratically. This version was not land-tested prior to shipboard deployment because of scheduling pressures. Since the Geoprops Probe requires a functioning MDCB, the next test of MDCB could be dovetailed with a test of the Geoprops Probe.

The Sonic Core Monitor (SCM), intended to locate core pieces during partial recovery and to provide information on core orientation, was used during Leg 134. The SCM is a memory tool. Problems were encountered with the electronics, which are not sufficiently robust to withstand shocks and vibrations typical of an ODP drilling environment. Work is now underway towards the SCM Phase 2.

The new strengthened side-entry-sub is still not being used to its full potential. The aversion is believed to be due to a psychological problem stemming from earlier difficulties with stuck pipe.

**10. Wireline Packer**

Scholz presented a detailed status report on the Wireline Packer, which had failed to perform on Legs 131 and 133. This report is attached as Annexure I.

His primary recommendation was that the wireline-packer concept should be progressed, but not with the existing tool which is incapable of being modified to match scientific requirements. Instead work should progress on a phase-2 version of the tool which would resolve the problems caused by the original design, especially that of sample contamination. Estimated (median) costs are $250 000 for one Phase-2 tool and a further $100 000 or so for a second tool.

The Chairman thanked Scholz for providing one of the most comprehensive and forthright reports that the Panel had ever received. This would be invaluable when the Panel debates a recommended strategy for downhole sampling under Agenda Item 12.

**11. Alternative Technologies for Downhole Sampling**

(1) Simplified Wireline Sampling

Payne (representing BP Exploration) reported that an approach had been made to TAM some two years ago to develop a wireline sampler for leasing. TAM had responded to the effect that one was already under development. Presumably this was the ODP tool. The specifications were much less stringent than for the ODP tool, requiring an operating temperature of up to 85°F, a 1000 ft depth range, a one-foot straddle packer, and on-board measurements of conductivity and temperature. The tool was originally specified to contain sample bottles but this specification was simplified to pump directly to the surface those fluids which it was desired to recover. Outside diameter of the tool is 3.5 inches. A similar tool has reportedly been run in Nevada for environmental control.

(ii) OBCAT System

The Chairman reported on an Oceanic Borehole Chemical Analysis Tool (OBCAT), designed by the University of Newcastle-upon-Tyne, England, with support from the UK Science and Engineering Research Council. The aim is to obtain formation-water samples of verified integrity. The tool is designed as a go-devil interfaced to the TAM/ODP two-element drillstring packer. The tool can be used to set the packer. The principles of operation are to monitor the chemistry of waters pumped from a packed-off interval, to relay information to the surface along standard logging cable, and to take a sample when instructed. Dimensions are : diameter < 60 mm; length 8.5 m; sample chambers 6 x 200 ml.

The operational details are as follows. Pump water above the packed-off interval and thereby create a pressure differential across the go-devil so that water is drawn from the packed-off section. A slimline high-pressure pump extracts water from this flow. This water is pumped through a sample chamber into a multi-sensor head where eight chemical characteristics are measured. These are T, pH, conductivity, $E_h$, $Cl^-$, dissolved $O_2$, dissolved $H_2$, and $S^{--}$, with possibilities for alternatives to be substituted, e.g. $Ca^{++}$. A ninth sensor, outside the multi-sensor chamber, registers flow. The data are transmitted via a logging cable for surface display in real time. When data consistency is observed, the sample chamber is closed. Flow can then be directed through another chamber. The packer can subsequently be deflated and positioned at another location.

The tool has been field-tested in two test holes at BPB Industries, using 22000 ft of logging cable. The tool functions correctly but three problems have been exposed : the need for a non-corrodible solder on the pipework, the robustness of the electronics, and a requirement for spare parts. The current temperature rating is 90°C : there have been no hostile environment tests to date. It is estimated that it would require 6-9 months and £15 000 to rectify the shortcomings and complete the tool. At present, this work is not progressing but an appropriate Panel recommendation would act as a catalyst. It was noted that the present ODP drilling/fluid system might not allow a sufficient pressure drop to provide the necessary suction for successful operation.

(iii) <u>Commercial Repeat Formation Testers</u>

The Chairman reviewed the specifications of commercial formation testers.

| Company | Tool | Temp (°F) | Tool Diam. (In.) | Minimum Hole Size (In.) | Maximum Hole Size (In.) |
|---|---|---|---|---|---|
| Atlas | FMT | 350 | 5.13 | 5.88 | 9.88 |
| | | | 6.25 | 7.13 | 12.25 |
| | | | 7.88 | 8.75 | 16.00 |
| | | | 9.19 | 10.13 | 20.00 |
| BPB* | SRFS | 300 | 3.50 | 4.00 | 6.00 |
| Schlumberger | RFT | 350 | 5.20 | 6.50 | 15.50 |
| | RFTTN-OH | 400 | 3.38 | 4.75 | 6.75 |
| | MDT | 400 | 4.75 | 6.00 | 14.25 |
| Halliburton | SFT | 375 | 5.50 | 6.25 | 14.25 |
| | SFTT-B | 375 | 4.75 | 5.50 | 8.63 |
| | | | 6.50 | 7.38 | 19.00 |

* development phase

| | | | | | |
|---|---|---|---|---|---|
| FMT | - | formation multitester | SRFS | - | slimhole repeat formation sampler |
| RFT | - | repeat formation tester | SFT | - | selective formation tester |
| RFTTN-OH | - | ditto, slimhole, HE | SFTT-B | - | sequential formation tester tool |
| MDT | - | modular formation dynamics tester | | | |

These conventionally use a doughnut seal pressed against the borehole wall, rather than a packer, and therefore they are likely to be of little value in secondary aquifers. In no case can a commercial tool fit down the ODP drillpipe (4 inches) and expand to sample in a typical ODP hole (13 inches diameter). Schlumberger have no interest in developing a slimhole formation tester with this capability. This underscores the need for novel technology such as the Wireline Packer.

The Panel discussed a way in which commercial tools might be used in ODP holes. This would involve wireline re-entry while the ship is still on station. The drillstring could be removed and then a conventional formation tester run in conjunction with the side-entry-sub and with a TV camera for re-entry. This approach, which would require a dedicated trip, it is most likely to produce useful samples in compacted sediments.

(iv) <u>WSTP</u>

Fisher reported on the ($23 000) upgrade of the WSTP which had been requested for Sedimented Ridges I. Recorders and timers have been rated to 125°C. There are two thermistors, one with a range 0-60°C and the other 50-200°C. There is easier uphole downloading of data and sample for analysis. The tool tips, filters, fittings and tubing are made of titanium. The probes are longer, narrower and stronger. There are two disadvantages: (a) extra running time due to cleaning requirements; and (b) the possibility of the tool flooding if the probe tip is broken off, because of the absence of a high T,P small pass-through.

(v) <u>Equilibration of Boreholes</u>

With the emergence of borehole-sealing technology, an option is to allow boreholes to equilibrate after drilling and then to recover samples through an instrumented seal. These could be monitored with time to verify consistency. Such a system would overcome any potential contamination problems due to a downward flow of seawater within the borehole.

12. **<u>Strategy for Downhole Sampling</u>**

Anderson stated that if the Panel wished to progress the Wireline Packer along the lines proposed by LDGO (Item 10), a strong Panel endorsement of the LDGO proposal would be needed for implementation in FY92 and a ringing endorsement for implementation in FY91.

The Panel view was that the present Wireline Packer was an engineering failure. The Panel had previously expressed its grave reservations about how the project had been handled in the development stages. The project had also been disadvantaged by the environmental conditions imposed, i.e. the need for a slim and therefore a very long tool with storage and differential pressure implications, the need for a packer expansion by a factor of more than three, and the absence of fluid loss control during drilling. The outcome was that even if the tool had functioned perfectly, there is no guarantee that the recovered samples would be uncontaminated by drilling fluid. There was a high probability that a Wireline Packer Phase 2 would not produce the information required for scientific purposes. Therefore the Panel could not provide the endorsements indicated by Anderson as prerequisites for further development.

Mienert and McClain both reiterated strongly their panels' need for good samples of pore water. This is a major scientific requirement. Fluid composition allows the calculation of fluxes and provides important information on hydrothermal processes. Gieskes noted that we need to obtain formation waters from Layer 2: that is the whole philosophy of the Wireline Packer. Mienert stated that we need a tool that gives the correct chemical information but, if this is not possible, we need to know the inaccuracy. If the Wireline Packer is not available, SGPP want to know which tool(s) to use. Carson emphasized that the Wireline Packer, the commercial formation testers and the OBCAT tool all have the same disadvantage: it could take long periods to obtain samples of the required purity, notwithstanding that these might be irrecoverable. At the very least, the importance of the sampling issue suggests that we should consider it separately from the question of permeability.

In summing up, the Chairman recognised that the need for fluid samples had not gone away but that there was insufficient evidence that the Wireline Packer was a realistic way forward. The Panel proposed that the Wireline Packer be shelved, rather than abandoned, pending the input of further specialist advice. The following consensus was obtained.

**DMP Consensus**

**The Panel reaffirms its commitment to the scientific objective of obtaining uncontaminated fluid samples downhole. At present, ODP does not have a functional wireline sampler through which this objective can be achieved.**

The Chairman pointed out that if the Panel wished to recommend specialist input, this would have to be received outside the framework of Panel meetings, which were already full for 1991. Mienert observed that this input should be available for the joint DMP-SGPP meeting in June 1991: it would therefore have to be generated through a separate event. After much deliberation, the Panel formulated the following recommendation.

**DMP Recommendation 91/1**

**"The two basic issues governing fluid sampling are the engineering of the tool and the scientific integrity of the sample. Both of these aspects should be examined by a specialist working group or workshop with a view to identifying the best available options for downhole fluid sampling in ODP-type situations. No new tool developments should take place until these issues have been resolved."**

The rhetorical question was asked as to why the substance of the above recommendation had not been pursued at the outset. It might have saved the $250 000 already spent on the wireline packer.

The Chairman commented that DMP Recommendation 91/1 raises the importance of the Geoprops Probe which might well provide a short-term solution to the fluid-sampling problem. The first leg for which Geoprops is needed is Leg 141 and thereafter Legs 143 and 144. It is not required for Leg 139 because the in-situ temperatures are likely to be too high when indurated sediments are encountered. The tool is only rated to 100°C.

**DMP Recommendation 91/2**

**"The Geoprops Probe should be subjected to further land tests after the remaining necessary modifications have been made. Subject to a satisfactory performance in those tests, the Geoprops Probe should be tested at sea by ODP at least two legs prior to its proposed scientific deployment, in order to allow adequate time for any residual modifications to be made."**

It was reiterated that these tests would have to be dovetailed with the deployment of the MDCB.

## 13. TAMU Computer Briefing

Meyer reported that the shipboard computer system is in the best shape ever (Annexure II). Previously exposed problems have been solved. In particular, the lack of disc space on the VAX has been rectified and the networking problems have been solved so that all systems (including LDGO) can exchange files. The VAX workstation for FMS processing has been tested and is operational. The number of PCs is increasing.

As regards shipboard data acquisition, the multi-sensor track (MST) has been upgraded from the standpoint of automatically recording GRAPE, magnetic susceptibility, and the P-wave logger. It is proposed to add the natural gamma. There is a question as to whether irradiation by GRAPE will have an adverse effect on the natural gamma data.

The shipboard integration of core and log data is being addressed in two stages, (i) through the integration of all core data, and (ii) through the integration of core and log data. Item (i) was addressed during Leg 134. The MST was used to provide a reference depth scale for all core data. It was overwhelming to the shipboard scientists to see all the core data together: they couldn't handle it. The earlier DMP/SMP recommendation of a dedicated correlation scientist is therefore essential. To achieve the integration of core data, the system manager had to postpone preventive maintenance. A second shipboard system manager will be needed, at least during the further development of the integrated system.

Mefferd reported on the shipboard processing of FMS data. The FMS was run in three holes during Leg 134. All data were processed. This usually took 3-5 days after receipt of the tapes, depending on the number of requests for plots at different scales. If two passes have been made with the FMS, the processing takes longer, partly because of the need to depth match. There is great interest in FMS data but shipboard scientists don't have the time to use them fully because of the basic chores that they have to do routinely. There is a human limit to what can be achieved. A possibility is to focus on intervals where core recovery is poor, in the first instance. This would provide the most important data at the earliest possible time.

Fisher commented that there are depth-match requirements associated with the FMS, with conventional logs and with core data. All of these are unconstrained. No one is unifying depth at the moment. There is no quality assurance. The designation of a correlation scientist is the only way one can count on this happening.

Bernstein demonstrated the computerised barrel sheet system. The aim is to capture the data electronically while the barrel sheets are being constructed. This system is being used on the current leg. The sheet has been changed to remove palaeo-data and to truncate some columns. This furnishes a narrower sheet with more space for inserting data for correlation.

**DMP Consensus**

**The Panel congratulates the ODP/TAMU Technical Service Group on the excellent progress towards the shipboard computer-based integration of core and log data.**

**DMP Recommendation 91/3**

**"The growing demands on systems staff arising from shipboard computer-based data integration is making it necessary to have more computer technical support on board ship, at least for the time being. The level of this support should be sufficient to ensure that the data integration goals can be achieved."**

14. FY91 and FY92 Logging Programmes

Jarrard and Fisher provided updates on the FY91 logging programme.

Leg 136 Oahu

The analogue BHTV will have to be run because the German digital tool is not functional at present. A question remains concerning BHC vs LSS tools for the cement-bond-mode sonic log (cf. Item 4).

Leg 137 Hole 504B

The Los Alamos National Laboratory (LANL) and the Lawrence Berkeley Laboratory (LBL) fluid samplers are to be tested on this leg. There have been earlier doubts concerning their performance but the tools will reportedly have been upgraded prior to this leg.

Leg 138 Eastern Equatorial Pacific

No change.

Leg 139 Sedimented Ridges I

The Geoprops Probe will not be run for scientific purposes (but cf. DMP Recommendation 91/2). Otherwise the logging plan is essentially as recommended by DMP.

The logging programme at the seven primary sites is as follows.

MV-6 (420-450 m sediments: < 50 m basement)

| | |
|---|---|
| Standard suite | Temperature (High-T) |
| VSP | WSTP |
| Dual laterolog | APC-T |
| Fluid sampling | |

MV-6 (120 m sediment: 0 basement)

| | |
|---|---|
| WSTP | APC-T |

MV-3 (470 m sediment: 50 m basement)

| | |
|---|---|
| Standard suite | WSTP |
| Temperature (High-T) | APC-T |

Re-entry Hole:

| | |
|---|---|
| Standard suite | Temperature (High-T) |
| Dual laterolog | Packer/Flowmeter |
| BHTV | Borehole seal |
| Fluid sampling | |

MV-1 (90 m sediment: 60 m basement)

| | |
|---|---|
| WSTP | APC-T |

Re-entry Hole:

| | |
|---|---|
| Standard suite | Temperature (High-T) |
| Dual laterolog | Packer/Flowmeter |
| Fluid sampling | Borehole seal |

MV-7 (250 m sediment: 50 m basement)

| | |
|---|---|
| WSTP | APC-T |

Re-entry Hole:

As for re-entry hole MV-3

The dual laterolog has been included because the formation resistivity might be too high for the induction. The proposal to run the Geochemical Logging Tool (GLT) through pipe for sulphide detection in very shallow holes has not been adopted. Hole cooling will not be practised as this would damage the environment and preclude temperature logs. The high-temperature logging cable will be on board at the beginning of this leg. As yet, it is not known which cable that will be. A 7-conductor TFE cable would seem appropriate. Morin reported that the USGS has such a cable. He agreed to explore the possibility of USGS donating about 200 ft to ODP to allow wireline operations in high-temperature zones by splicing.

**[ACTION:MORIN]**

Jarrard introduced the FY92 drilling schedule together with a proposed logging programme (Annexure III). The FY 92 programme begins with Leg 140, which depends on the results of Leg 137.

Leg 140 Hole 504B

The deepening of 504B would see the logging programme as previously recommended by DMP with the following subsequent DMP-approved addenda; packer/flowmeter and borehole seal. (Note: Item 7(vi) makes no reference to 504B for instrumented borehole-seal deployment).

The GLT is to be run again to allow a comparison of logs with and without the boron sleeve and because the earlier (unsleeved) log was of poor quality. It is proposed to add a high-spectral resolution geochemical tool to the logging suite because elemental flux arguments make this an ideal site.

**DMP Recommendation 91/4**

**"A high-spectral resolution geochemical tool should be run in Hole 504B during Leg 140, in addition to the standard GLT. This will allow a comparison of sodium-iodide and high-resolution detectors as well as providing important new elemental flux data. The high-spectral-resolution tool should be subjected to land tests and full performance evaluation prior to deployment."**

Leg 140 or 147 Hess Deep

This is not yet a mature proposal but it is evolving. No new proposal has emerged since the last Panel meeting. The logging programme is likely to be similar to that at 504B or 735B.

| | |
|---|---|
| Standard suite | Dual laterolog |
| Temperature (High-T) | VSP |
| BHTV | Packer/Flowmeter |
| Magnetometer/Susceptibility | Drillstring packer |

The inclusion of the packer/flowmeter presupposes that this tool will perform satisfactorily in earlier deployments. The logging programme will be refined when the proponents have developed a mature proposal.

Leg 141 Chile Triple Junction

This has previously been considered by DMP who recommended a standard logging programme with the wireline packer, geoprops probe and WSTP at selected sites. The WSTP should be the primary sampling tool. The wireline packer is withdrawn. Geoprops can be deployed on this leg, perhaps as a trial, in conjunction with the MDCB. This leg is also a possible leg for testing the LAST tool prior to its use at Cascadia (but cf. DMP Recommendation 91/2). Standard logs are being used to document gas hydrates. The pressure core barrel is to be used for sampling gas hydrates.

Leg 142 EPR Engineering

The principal aim is to evaluate the DCS Phase 2. Essential downhole tools are temperature logs and fluids samplers. In addition the BHTV is to be run, either the German dewared tool or the slimhole tool, depending on downhole temperature. If the DCB 7-inch hole is successful, logging with standard tools might be accomplished.

Legs 143/144 Atolls & Guyots A/B

These have not previously been evaluated by DMP. The proponents have included standard logging for most sites. A key issue is the link to seismic which might be satisfied by the sonic log. Panel suggested one zero-offset simplified VSP (for check-shot purposes) per leg, to enhance the sonic tie to seismic. Another key issue is the geochemical characterisation of the successions. If the enhanced-resolution geochemical log is successful at 504B, it should be considered for deployment in selected holes here. It is worth noting that Leg 134 drilled a guyot and geochemical logs provided clear messages that were especially valuable in cases of poor core recovery.

**DMP Recommendation 91/5**

**"In addition to standard logs and targeted check-shot VSP, an enhanced-resolution geochemical log should be run in selected holes during Legs 143 and 144, provided that earlier deployments are considered successful. Such a tool could greatly enhance the geochemical characterisation of drillhole sites, especially with regard to trace elements."**

Leg 145 North Pacific Transect

This proposal has not been evaluated by DMP. Sister legs are Ontong Java and Eastern Equatorial Pacific. Panel proposes full standard logs regardless of core recovery. In addition the French high-resolution magnetometer/susceptibility tool should be run in selected holes. There might be sufficient signal to detect downhole reversals and the susceptibility will be useful for core-to-log ties, site-to-site correlation, and as an indicator of variations in palaeo-wind characteristics.

**DMP Recommendation 91/6**

**"In addition to standard logs, high-resolution magnetometer and susceptibility tools should be run in selected holes of the North Pacific Transect (Leg 145)."**

Leg 146 Cascadia

The earlier DMP recommendations have been accommodated with a reservation concerning the time-consuming combination of wireline packer and geoprops probe. Panel view was that the wireline packer should be withdrawn. A proposal has been submitted by Greg Moore for funding an extra ship for 2.5 days to run an offset VSP with three-component tools. Panel encouraged this initiative but accorded it a lower priority than the basic logging programme.

Add-On Science

The Chairman referred to a letter he had received from Roger Larsen proposing a return to Re-entry Hole 801C in order to carry out the downhole measurements programme that could not be done when the hole was drilled during Leg 129. In many respects, 801C is a reference hole in that it penetrates old Pacific crust. To some extent, the hole is also a substitute for the geochemical reference holes, which were never drilled. The logging programme therefore seems especially desirable as a contribution to the scientific goals and legacy of ODP. The Panel supported Larsen's proposal and reiterated its earlier Recommendation 90/1 with the following modified wording.

**DMP Recommendation 91/7**

**"Since Re-entry Hole 801C is located just three days out of Guam, the port call between Legs 143 and 144, this hole should be re-entered and the previously aborted programme of downhole measurements carried out. This exercise should be regarded as an addendum to the FY92 ODP programme. This is an important issue because Hole 801C penetrates very old oceanic crust and there is no provision for ODP to drill crust of similar age in the future."**

15. **Borehole Stability in Tectonically Active Areas**

This Agenda Item was conducted as a working subgroup of DMP with a number of specially invited guests. The subgroup had been convened by Fisher and Karig as an integral part of this DMP meeting. Fisher provided the following report:

This meeting had been called to discuss hole instability problems common to tectonically active regions. In particular, it was intended to discuss drilling, coring and logging results from Legs 110 (Barbados Accretionary Complex) and 131 (Nankai Trough) with an eye towards upcoming Legs 141 (Chile Triple Junction) and 146 (Cascadia Margin). As an introduction, Fisher noted that the drill ship does not have a riser/return system and that our primary drilling fluid is sea water. In addition, the ship generally drills widely separated holes in varying lithologies, so that we often have limited prior insight into the formations to be drilled. During the last five years a great deal of effort has been expended to counteract hole stability problems, but this drive has been primarily directed towards unstable sands, swelling clays and hole cleaning. Our ability to log holes has improved significantly during this period, but experiences during Legs 110 and 131 were sufficiently bad to suggest that fresh ideas might be needed.

Foss explained that we have been able to keep holes clean, as long as hole geometry is good, but that we cannot keep a mud cake on the hole wall because we cannot afford to drill/core with mud. The main problems we encounter on the ship are fractured/disaggregated formations, flowing sand, clay swelling/sloughing, hole erosion and degradation (due to circulation and time), cutting avalanches, and bridging and ledging. We core continuously, and usually circulate throughout, except when breaking the pipe. When we pull cores, we slow circulation. We usually don't have problems with cuttings until we get to about 200-300 mbsf. Preventive measures taken during or after coring (mud pills, wiper trips) may or may not help, depending on conditions in the hole and the lithologies encountered. In some cases they may actually be harmful. It might be best to case off the uppermost, unstable sections of holes, either with a complete re-entry system or with the new, drill-in casing (DIC) system first deployed successfully during Leg 131. This system has recently been modified to include a mini-cone at the top. Cementing has been tried in fractured rock on the Mid-Atlantic Ridge, and was successful over only short (a few metre) intervals. It is likely to cause side-tracking in less indurated sedimentary formations.

Karig suggested that the majority of our problems during Leg 131 may have been mechanical. He showed a plot indicating that in any accretionary environment, where the largest principal stresses are oriented horizontally, borehole stresses may exceed the strength of the rock by a factor of 2 or more, even close to the seafloor. Breakouts are therefore to be expected. In accretionary environments, horizontal stresses may be 1.3-2.4 times higher than vertical stresses. After the upper sandy intervals were cased off during Leg 131, instability problems seemed to be restricted to the zone between the upper thrust and the decollement. Fill and sticking were greatly reduced below the decollement. There was smectite in the lower part of the section, but this material should be relatively impermeable, meaning that the chemical effects should have been restricted to a narrow region near the borehole. Also, high pore pressures should have kept drilling fluids out of the formation. Finally, clays should not be expected to swell much, except in the presence of fresh water.

Moos suggested that in-situ stresses could be the primary factor contributing to borehole instability in accretionary complexes. In fact, the distribution of stresses throughout the world suggests that compression may be the rule in much of the seafloor, and accretionary complexes may essentially be at failure even before drilling. In the past, people have assumed that the largest horizontal stresses should be about 1/3 of the overburden, but the two stresses may actually be similar. Stress concentrations are magnified by a factor of about 3 around boreholes. Weighted mud could help keep holes open, but could also induce hydrofracs with depth. This might not actually be so bad, as long as it did not degrade hole conditions, for it might allow the determination of stress orientations with the FMS or BHTV.

Morin discussed thermal stresses in boreholes and noted that reducing temperatures at the borehole wall puts the rock in tension at the maximum horizontal stress. Adding hot fluid to cold rock induces breakouts at the minimum horizontal stress. We could actually create hydrofracs at depth and breakouts near the surface through water pumping in the same hole. There is good evidence that this has happened in Hole 504B.

Pace explained that oilfield drillers usually control mud density through careful monitoring of returns, a technique not available to ODP. Industry also attacks surface hydration and osmotic forces through mud chemistry. Our ability to act here is also reduced, but we might be more successful if we pumped regular pills of polymer muds during all drilling and coring. Once breakouts form, it might be too late to act. Seawater chemistry is actually favourable much of the time, but we perhaps need to work on viscosity and density.

In a general discussion it was agreed that the ODP cannot afford to pump muds continuously. Heavy mud may be needed in accretionary environments to hold boreholes open long enough to log when lateral stresses are large. We have a limited budget, and limited space for mud and drill water storage. Although mud is sometimes pumped into ODP holes before logging, it has not generally been very heavy mud. It is easy-to-mix mud with a weight of up to 12 lbs/gallon on the ship, but higher weights will require more time-consuming mixing/agitation and more room for storage prior to pumping downhole. Pace suggested that there are heavy mud formulations available which could be maintained with existing facilities.

The possibility of drilling smaller holes was discussed, but this is going to take time to develop. The DCS system will not be available for Cascadia drilling. A hole this small (4") creates other problems because most logging tools will not fit in it. A small hole would take less mud to drill, however, and thus might allow more mud use. A 6" hole is probably the smallest that can handle conventional logging tools. We currently drill our smallest (non-DCS) holes with 9-7/8" RCB bits, 5" and 5-1/2" pipe, and 8-1/4" collars. Using 6" and 7" pipe might increase annular velocities but would be heavy and expensive. These possibilities are being explored by ODP engineers.

Slimhole DCS coring/drilling techniques likely to induce less formation damage could also require less "high-tech" drilling mud. A minimum hole size necessary to achieve downhole objectives should be considered by scientists planning legs during which DCS drilling may take place.

The working group agreed on the following recommendations and related observations pertaining to logging in accretionary complexes. These have been adopted by the Panel. Many of these comments could be applied to logging in general. It is appreciated that the scientists planning legs are best equipped to consider this information, anticipate lithologies, and evaluate the relative importance of diverse scientific objectives before working out a strategy for drilling, coring and logging. It is also recognized that their choices will have an economic impact on operations.

**DMP Recommendation 91/8**

**"The following options should be considered to enhance the prospects of borehole logging in accretionary complexes.**

**(i) Case off the upper portions of unstable holes either with a full re-entry system or using the drill-in-casing system (DIC) with or without a mini-cone.**

**(ii) Drill offset dedicated holes for logging where cored holes become unstable; the dedicated holes can be drilled quickly to reduce exposure of the formation to seawater.**

**(iii) Log deep holes in several stages: during XCB drilling, this should not require additional pipetrips; during RCB drilling, additional trips may be needed.**

**(iv) After drilling and coring, flush logging holes clean and then fill with heavy mud, probably weighted with barite, with a weight of at least 12 lbs/gallon. In many cases, mud density approaching the formation density (19-22 lbs/gallon) will be more appropriate. Facilities and time on the ship will need to be available for mixing and delivering such a heavy mud. Flushing holes clean before using heavy mud may require pumping large volumes of fluid, particularly in cases where hole erosion is severe. The presence of barite mud will probably preclude lithodensity and photo-electric measurements (and will thus also reduce the quality of geochemical log measurements), but should have little impact on sonic, neutron porosity, natural gamma, resistivity and FMS logs. Borehole fluid sampling, packer measurements and BHTV runs will be compromised through the use of heavy mud (requiring that these measurements be made before heavy mud is pumped or in separate holes), but temperature logs may be improved if borehole convection is reduced.**

**(v) The need for heavy mud for each proposed hole should be identified and discussed by the co-chiefs, logging scientists, LDGO BRG representative and operations superintendent during the precruise meeting.**

**(vi) As with drilling muds, add chemical inhibitors and viscosity enhancers to logging muds when necessary.**

**(vii) Recognise that the sidewall-entry-sub (SES) is not designed to allow logging in unstable holes; it is best used in good holes with minor bridging problems.**

(viii) **Deploy short logging strings where these are significantly easier to run than long strings.**

(ix) **The time needed to make special preparations for logging must be included in time estimates for all legs during which these preparations are expected to be necessary."**

**DMP Recommendation 91/9**

**"Because expensive ship time has been wasted and tools have been lost while trying to log unstable holes, at least a major portion of a future engineering leg should be devoted to evaluating borehole stability strategies in an accretionary setting, in preparation for upcoming scientific programmes."**

In summary, it should be possible to increase our ability to log in tectonically active regions, but it will take advanced planning and ship time, and it will be somewhat more expensive. While at sea, the decision to pump heavy mud will be made by the operations superintendent, in consultation with the co-chiefs, logging scientists, and LDGO BRG representative. Ultimately the importance of the scientific objectives which could be achieved through logging should be given strong consideration by those scientists planning future legs.

## 16. High-temperature Tools

### (i) Temperature & Pressure

Anderson reported that the JAPEX PTF (pressure, temperature and flow rate) combination tool had been satisfactorily tested in a geothermal well. LDGO had been instructed by JOI to commence negotiating a contract with JAPEX for a 6-8 month lease of the tool at around $5000 per month. This would allow a land test in May and possibly shipboard deployment thereafter.

Lysne commented through the Chairman that he couldn't offer a Sandia tool for a back-to-back land test, as previously recommended by DMP, without having the exercise fully funded by ODP. Sandia has submitted a proposal to JOI, in response to a trawl, for developing high-temperature P and T capability.

Another possibility is the French high-T temperature tool.

The JAPEX and French tools are wireline tools. Sandia have a wireline tool and a memory tool.

### (ii) Fluid Sampling

The LANL and LBL tools are scheduled for testing on Leg 137. They are being upgraded in the meantime. Respective tool diameters are < 2" (LANL) and 2.25" (LBL). The Sandia tool has been lost so SNL no longer have a sampling capability.

The aim is to seek redundancy in both temperature measurements and fluid sampling. The various tools are not in competition but are being evaluated in terms of absolute standards of performance. If two tools perform well, they can both be admitted.

(iii) Formation Resistivity

Anderson reported that the ARCO tool is in poor condition and LDGO recommend that it should not be double-dewared. The alternative is to purchase a slimhole tool (c. $30 000) specifically for double-dewaring. There is a need for a full engineering analysis of the double-dewaring problem in order to avoid difficulties later. The Panel felt that this was a high-risk venture but that it should be progressed because of strong thematic interests. There is some flexibility for reprogramming later if the higher priorities of temperature and fluid sampling run short of funds.

[Chairman's post-meeting contemplation. If a resistivity tool is to be double-dewared from scratch, it should be the simplest quantitative tool available. The Normal device would appear to offer the best compromise between tool simplicity and measurement capability. It can be made very slim and would benefit enormously from being run in a DCS hole rather than a large-diameter hole. The Normal device suffers from less perfect resolution, a shallower depth of investigation, and greater borehole effects than a laterolog. These problems could be partly overcome by the age-old ploy of using two Normal devices concurrently. With modern processing technology the shorter-spaced device could be used to define electrical boundaries, and the longer-spaced component to determine the resistivities using these boundary conditions in the model. All this should be well within the capability of a technician/student combination. This is not a Panel recommendation, but merely the documentation of some potentially useful thoughts, which the logging contractor is invited to consider.]

(iv) General

Lysne proposed through the Chairman that there is a need for interested parties to meet in order to chart a way forward in the high-temperature logging area, especially as there might be opportunities for interprogramme collaboration. Panel made no further recommendations at this time.

## 17. Wireline Re-entry

Deferred to the next meeting with apologies to the presenters.

## 18. Panel Membership

Three nominations have been received to replace Bobb Carson. Their names are not minuted in accordance with PCOM policy. The Chairman would approach these persons to ascertain their interest, to obtain brief resumes, and to progress the paperwork together with appropriate recommendations for the consideration of PCOM.

**[ACTION:WORTHINGTON]**

Heiner Villinger is to be replaced as the FRG Representative by Hans Draxler of KTB.

## 19. Next DMP Meetings

The Chairman noted that the Panel cannot function with less than three meetings per year. The Panel does not have the option to meet more frequently because of the need to contain costs. The plan for the next twelve months is therefore to continue with the policy of three meetings per year, but requesting extensions of these meetings where appropriate, e.g. to accommodate joint meetings with other panels.

The next meeting of the JOIDES Downhole Measurements Panel is scheduled to take place at the Lamont-Doherty Geological Observatory, Palisades, New York, during the period 4-6 June 1991. This meeting will include a joint session with the JOIDES Sedimentary and Geochemical Processes Panel and will encompass a tour of LDGO Borehole Research Group facilities. LDGO Liaison to host.

The subsequent DMP meeting is proposed to take place in Victoria, British Columbia, Canada, during the period 11-13 September 1991. This meeting would hopefully include a joint session with the JOIDES Shipboard Measurements Panel and would provide a further opportunity for a shipboard tour of the JOIDES Resolution. Canadian ODP Secretariat are asked to host.

The following DMP meeting is proposed to take place in Hawaii in mid-to-late January 1992. This meeting would hopefully embrace a geological field excursion. Wilkens to host.

## 20. Bromide Tracer Experiment in Hole 504B

Gieskes requested the Panel's endorsement of the following proposal.

During Leg 137 it is proposed to introduce a small quantity of sodium bromide (NaBr) into Hole 504B at the end of operations while preparing it for future re-entry. The NaBr would be mixed with surface seawater onboard, and introduced into the hole during the final stages of cleaning. The specific purpose is to add a tracer so that samples obtained during the next re-entry of Hole 504B, possibly during Leg 140, can use this tracer to establish the amount of mixing associated with the downhole flow of bottom water and exchange with basement fluids.

Sea water contains approximately 0.86 millimoles per liter (0.86 mM) of bromide ions, which compares to a total halide concentration of 559 mM, i.e., 0.15% of the total halide concentration. Bromide is an unreactive constituent in sea water, showing a constant ratio to chloride throughout the ocean with an implied residence time of well over one million years. It is proposed to spike the surface sea water that is to be introduced into the hole to approximately 3.5 mM, increasing the dissolved Br concentration by a factor of four. This would result in a change of the total halide concentration of under 0.5% and of sodium of under 1%, very close to the analytical precision of these constituents. We can determine Br quite accurately to 2% and thus any changes in the Br concentration and the Br/Cl ratio would serve as good indicators of mixing with other fluids. Br will act as a non-contaminating, conservative, non-reactive tracer. The four months between ODP Legs 137 and 140 should be sufficient to allow the determination of the quantity of downhole mixing into the upper 500 m of basement.

A minimal amount of NaBr will have to be added to the surface water for the desired increase in concentration. About 400 mg NaBr will be added per liter of surface seawater, or 30 kg NaBr per hole volume of 110,000 litres. The operations plan has been discussed in detail with ODP/TAMU, who consider it to be feasible. Due to the non-reactive nature of NaBr, and the negligible effects on the overall chemistry of the introduced seawater, it is felt that this experiment will serve its purpose.

The urgent approval was being sought of DMP, as well as of the Planning Committee, because time is running out for the purchase and delivery of the NaBr for Leg 137. An early endorsement is urged for this potentially useful and environmentally innocuous experiment.

**DMP Consensus**

**Panel supports the proposal for a bromide tracer experiment in Hole 504B during and after Leg 137 as an important contribution to understanding fluid exchange with the upper basement.**

21. **Close of Meeting**

The Chairman thanked Panel Members, Liaisons and Guests for their contribution to the meeting. The Panel Members acclaimed Bobb Carson and Heiner Villinger who were rotating off. The Chairman thanked both for their contribution over recent years. He also thanked Andy Fisher for his gracious hosting of the meeting and acknowledged the Directorate of ODP/TAMU for their generous hospitality. The meeting closed at 1330 hours on Friday 8 February 1991.

PAUL F WORTHINGTON
18 February 1991

ANNEXURE I

# COLUMBIA UNIVERSITY

Lamont Doherty Geological Observatory
Borehole Geophysics

## Wireline Packer Project: Status Report

Prepared for
Downhole Measurements Panel
February 7-8, 1991
College Station, Texas

Prepared by
Erich Scholz

## Table of Contents:

## Introduction:

This document was prepared in response to a request by the Downhole Measurements Panel during the October. 15-16, 1990 meeting in Townsville, Australia. Design problems and failures encountered in the existing system, as well as future intentions, will be discussed. We initially considered 3 possible pathways towards the future of the Wireline Packer Project: 1) Abandonment, 2) rebuilding and upgrading existing units, and finally 3) redesign/reconfiguring for Version #2. We have made the following conclusions:

1) Abandonment: We do not recommend abandonment at this time because a) there is no hard indication that either the experimental or design concept is flawed to the extent that it negates successful deployment, and b) there is significant interest and need within the scientific community to warrant further work.

2) Upgrading existing units: The scheme is based on using the majority of the subsystems as is, with no major reconfiguring of the sonde. In our analysis we have determined that, while somewhat less costly, this approach cannot address completely the most critical problem identified in the existing system, which is of course, sample contamination. This is primarily because the sample fluid hydraulic system cannot be restructured.

3) Redesign/Restructuring for Version #2: This approach is based on a) the reconfiguring of the hydraulic system, b) restructuring of the tool sections, and c) redesigning the electronic and hydraulic circuits towards a modular system. In particular, this scheme resolves the problems inherited in the original design's evolution.

We consider the third pathway to be the best choice. References in the text as to tool modifications, redesigns, and budgets etc. refer to this plan. Whenever possible, components or subassemblies from the existing tools would be used.

## 2 Sample Contamination:

**Background:**

The problem most critical in the existing system is sample contamination. The problem is compounded in a number of ways but is primarily due to the location of the sample bottles in the sample fluid hydraulic circuit. The bottles are currently located at the end of the circuit rather than on the suction side or beginning of the circuit. The fluid path is currently, from interval to bottle, some 50 feet. The inlet to the bottles should be as close to the sample interval as possible and plumbed such that there is maximum flushing of the tubing leading to the bottles.

The following lists sources of contamination in the existing design:

1. Cross-contamination (caused by dead zones in the filter and ion sensor sections where fluid is not adequately flushed and mixing occurs).
2. Hydraulic fluid (from the pump power system)
3. Annulus fluid (if the interval bypass valve fails to seal)
4. Silicon fluid (from the ion sensor pressure compensator)
5. Ion sensor filling fluid (if the sensor bladder were to rupture)
6. Tool connections/hydraulic fluid (caused by locating bottle inlets in the connector alongside hydraulic oil connections).

The system utilizes a syringe-type sample bottle which, although the best choice for this system, has an unavoidable dead or initial volume. Considering that the existing design utilizes control valves that are only rated to 400 PSI and located in another tool section some 10 feet away, contamination is inevitable. In fact, these valves were intended only to prevent the pump from prematurely filling a bottle and must be opened periodically while the tool is being run into the hole to relieve differential hydrostatic pressure.

Additional problems:

a) Post-acquisition, the sample is maintained at pressure by a check valve. Check valves could leak causing the sample to degrade, i.e. out-gas.

b) The valve control electronics have proven unreliable and occasionally actuate the wrong valve(s); more importantly, there is no feedback to the operator at surface as to which valve was actuated.

c) Sample bottles are constructed with 410 stainless steel which is stronger than 300 series stainless steels (316S.S.) but does not provide adequate corrosion resistance, i.e. samples could be contaminated by the sample bottles.

## Solutions:

The intention of redesigning the sample fluid circuit is to minimize the unknown or contaminant sources such that sample quality is maintained and predictable. The sample or packed interval will continue to present a mixed volume but other contamination sources can be eliminated or minimized. By mixed volume, we mean that once inflated, the packers isolate a zone containing annulus fluid that must be displaced. That fluid will not be directly displaced but will mix with the incoming formation fluid. Therefore, it is unlikely that a 100% formation fluid sample could be obtained (in a reasonable time period). A Dilution Series test method can be used to overcome this problem. In this method a minimum of 2 samples, spaced in time, would be taken and compared. Obviously, more samples would improve resolution. We have chosen 8 bottles per sample bottle tool section providing either 4 zones @ 2 samples/zone or 2 zones @ 4 samples/ zone. In addition, an operator may elect to sample the annulus fluid to provide a background or control sample.

By using a modular design, additional bottle sections could be added to a tool string without modification to the sonde. For that matter, more bottles could be added to the tool section with the only restriction being overall length. A modular design also allows changes of bottle size or type, and control valving with minimal impact on system design. More on modular design later.

In order to achieve this objective, the sample bottle inlets must be located as close to the fluid intake as possible. Sample bottle type and control valving must be carefully chosen. We have elected to stay with a syringe-type sample bottle for the following reasons.

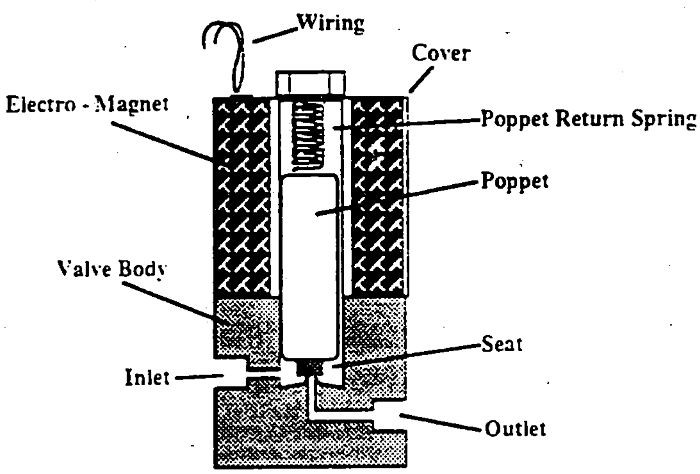
### Sample Bottles:

There are essentially three types of sample bottle designs; the Coil Tube, the Evacuated cylinder, and the Syringe. The Coil tube is favored among many chemists but would require twice the number of valves to control it. The Evacuated cylinder, on the other hand, is easily controlled but the extreme pressure drop at the orifice when the bottle is opened will damage the sample, gases in particular. Evacuated bottles do not afford control of differential pressure, critical in a large bottle volume. The Syringe combines the simplicity of the Evacuated with the only compromise compared to the Coil tube being the "dead volume". Were the control valve installed directly at the inlet to the bottle the"dead volume" would be limited to less than a C.C.

In preparation, the syringe bottle would be cleaned and then vacuum evacuated before closing the control valve. Downhole, the bottle is maintained evacuated until a sample is taken, then the valve must seal against positive pressure as the sample is returned to the surface. Therefore, bottle control valves must be rated to full hydrostatic pressure (10KPSI) and must seal bidirectionally and "bubble-tight".

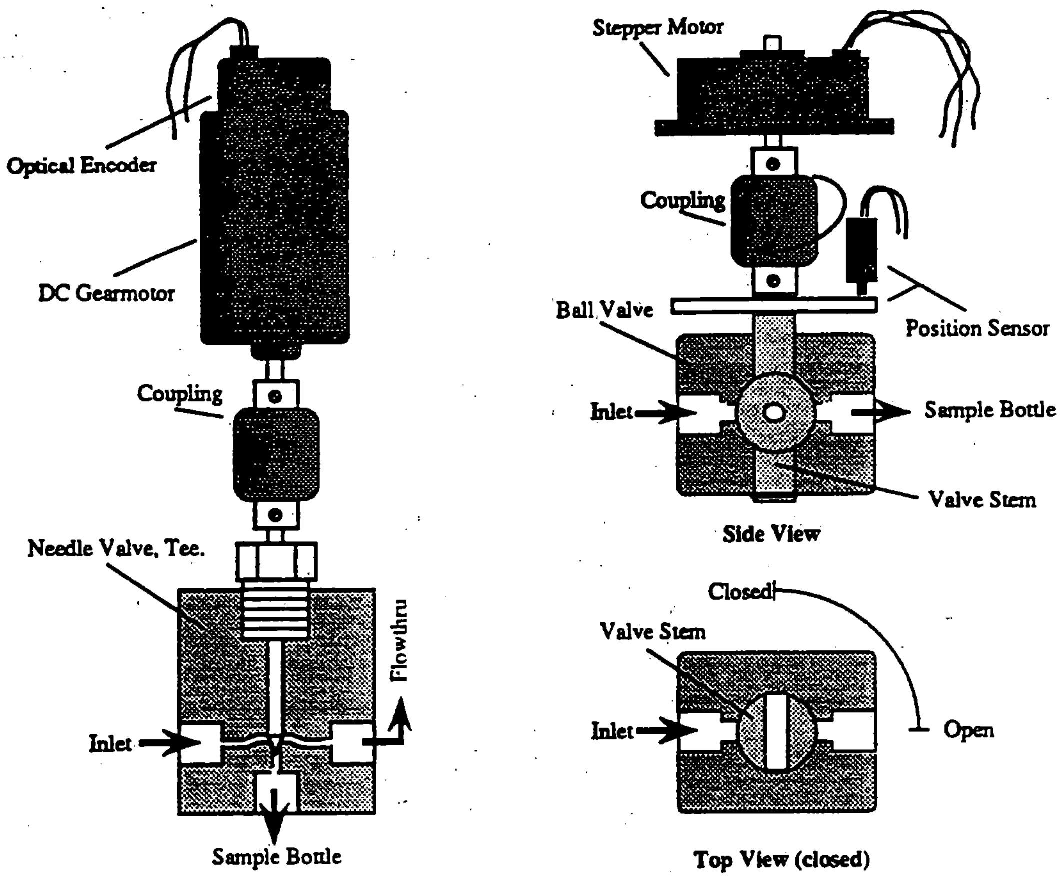
Valves:

There are basically four valve designs that are typically rated in this pressure region: the Solenoid valve, the Explosive valve, the Ball-valve, and the Needle valve. There are two types of solenoid valves; both are easily controlled by simply applying power to actuate the valve. Solenoids are attractive because the control is so simple. There is the Direct-acting valve and the Balanced poppet or pilot valve. Unfortunately, both designs have drawbacks. The direct-acting valve can only seal in one direction, as indicated in figure#1 The Balanced poppet design is available in higher pressures and most seal bidirectionally but, in order to maintain a "bubble-tight" seal, the fluid must be filtered to >1 micron. *Circle Seals Control*, for example, offers a 6KPSI valve and will quote a 10KPSI valve with some reservation about seat/seal life and "bubble-tight" specifications (even with filtration). Besides the high potential for clogging with such a fine filter, the geochemists I have consulted were not enthusiastic about the potential damage the filter could do the sample. We have elected not to use solenoids for sample bottle control (but will likely use several in the pump control circuit where sealing is not critical).




Figure#1: Typical Direct-acting Solenoid valve. Note that positive pressure at the outlet port will easily overcome the poppet return spring.

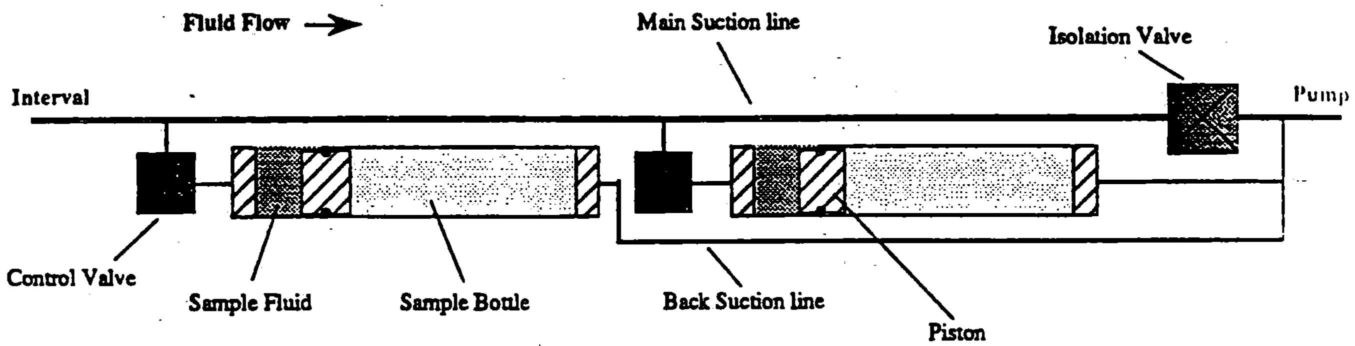
The Explosive valve is an interesting device typically employed only in high reliability applications such as munitions. The valve is comprised of a sliding spool that is operated by a small class "C" explosive. This valve is easily controlled requiring only a capacitive discharge circuit to operate it. The explosive charge and subsequent gases are captive in the actuator body and do not present a safety hazard. There is no exposure of the fluid to the explosive gases. The valves are guaranteed to pass a $10^{-7}$cc/sec Helium leak test at max. differential pressure (leakage in a fluid system would be nil). Unfortunately, the valves are single use and would cost between $700-1000 depending on quantity. It is unlikely that we would use an explosive valve.




Figure#2: Comparison of Needle valve vs. Ball valve designs with motor operators

A Ball valve design could be used, driven by a stepper motor. The typical ball valve "stem" rotates 90 degrees from positive Off to full On and back again. Sensing valve position is relatively simple using hall-effect or optical sensors and a perforated disc. See figure#2. Ball valves tend to be self--cleaning and less susceptible to damaged seats and seals (caused by particulates) than solenoids. A disadvantage is that 10KPSI nears the upper limit of the pressure rating for most ball valve designs. The *Swagelok Company* offers a 10KPSI Ball valve available in 316 Stainless or Hasteloy-C.

Needle valves are available in higher pressure ratings (in excess of 60KPSI) and have been employed towards this application in the past. The Barnes water sampler, for example, uses a motor driven needle valve. Both the Ball and Needle valve designs are somewhat long (5-8") and require more control electronics than the previously mentioned methods. A drawback to the Needle valve design is the lack of a positive indication that the valve is fully closed (because needle valves are "multi-turn" and valve stem wear can change where the stem seats). This is overcome in the Barnes design by torquing a rubber coupling which has proven effective. An advantage compared to the ball valve is a more reliable seal. *Autoclave Eng.* and *HIP Corp.* both offer a small 15KPSI rated needle valve that would be appropriate for this application.




Figure#3: Conceptual illustration of sample fluid circuit required to place the sample bottles in the suction circuit.

The suction circuit will operate in the following manner: During pumping cycles,fluid will pass through the main suction line to the pump via an isolation valve. When a sample is desired the isolation valve will be closed and the appropriate bottle's control valve opened. The pump will then remove fluid, via the back suction line, from the backside of the piston drawing it down the bottle until the bottle is completely filled with sample fluid. The bottle control valve will then be closed and the isolation valve opened.

We plan to use a motor-driven Needle valve for the bottle control valve. The decision is based primarily on seal reliability. The Isolation valve will be either a motor-driven Ball Valve or possibly a Solenoid (this seal is non-critical).

### Additional Modifications:

The geochemists I have consulted suggest that a 400 ml sample is much larger than required; in fact, 100 ml would still yield plenty of sample for shipboard experiments and archiving. There are other benefits to reducing the sample volume. For example, in order to retain a sample at pressure the bottle must be completely filled; in a lower permeability test interval a smaller volume can only improve that situation. Smaller bottles will also permit more bottles to be installed in a tool section without increasing the section beyond a manageable length. New bottles will be made reducing sample volume to 100ml. The bottles will be machined from Hastelloy-C, Titanium, or MP-35N to improve corrosion resistance.

## Modular Approach:

### Overview:

Modular systems are employed at various levels throughout the logging industry. Schlumberger utilizes a modular system exclusively. Likewise, the DMT digital televiewer is based on a modular design. In electronic design, each function (in the DMT tool for example, orientation, acoustics, gamma ray etc.) is controlled by an independent microprocessor communicating on a network or data bus. Each function is a Node that can be instructed and interrogated independently. Nodes, in general, would be comprised of a microprocessor, a serial communications controller, the appropriate power supply(s), and finally the front-end. The front end is tailored to the particular function be it data acquisition, valve control etc. Additional nodes can be added or removed from the tool string without effecting the another nodes function. This is be particularly beneficial if, for example, one wanted to add additional sensors or experiments to the base system. More importantly, this approach allows for the development of a common processor design where only the front-end and program code differs from node to node.

A modular system, with respect to mechanical and electro-mechanical design of a logging tool dictates that each tool section or cartridge be wholly independent and self supporting, i.e. a sample bottle section would contain not only the sample bottles but also the control valves and node electronics required to support the bottles. In another example, the pressure compensation cylinder for the pump/motor section would actually be located in the pump/motor rather than in the sample bottle section ( which, incidentally, provides for a tighter oil system).

### Background:

The existing system is a fixed system. Data acquisition cannot be adjusted (except by hardware modification) for changes to data rate, A/D gain, sensor type and number etc nor are there extra A/D channels or digital inputs (for a flowmeter) available. There is no implementation of gain range techniques that could be used to improve transducer resolution. Note that this becomes critical in the case of pressure measurement where data is presented in +/-2.5/3.0 PSI steps ( 10KPSI full scale @ 12 bit A/D resolution ) and the max. interval differential, with the standard packers, is limited to 350PSI. It is desirable to incorporate a software selectable gain-ranging amplifier with the ranges 0-5KPSI, 2.5-7.5KPSI, and 5-10KPSI. This was suggested by Baumgartner and myself at the first casing test at Tam International. At the time, in an attempt to improve resolution, the transducers were offset for a 5-10KPSI range ( question, how can surface or casing tests be conducted at low pressures if the transducers are fixed at 5-10KPSI? ).

The solenoid control is similarly rigid requiring a) that all valves be solenoids (of similar design and power consumption), b) that 2 valves and only 2 valves be actuated at all times, and c) that a max. of only 8 valves can be installed (to perform all tool functions including packer and pump control). What makes the system rigid is that the power supplies are of the constant current variety, i.e., the tool must consume a fixed amount of power in order for the power to be regulated and within spec.

The biggest problem, electronically, is data/command transmission. Data is transmitted to the surface and the solenoid "commands" sent from the surface via a half-duplex single-ended current modulation technique. There is no method for error detection or correction. There is also no feedback of "surface command" signals, i.e. valve positions, to verify that the tool is operating as instructed. Command transmission from the surface frequently results in errors leading to wrong valves or "extra" valves being actuated. Valve control is critical in this application and directly effects sample integrity. An operator cannot, with confidence, present samples to the scientific party under these circumstances.

Noise generated by motor operation compounds the problem primarily with respect to sensor data. Errors in the data are so high while the motor is running that, to date, an operator would need to shutdown the motor just to check the pressure. Again, since there is no error detection, erroneous data cannot be rejected by software and certainly can't be corrected.

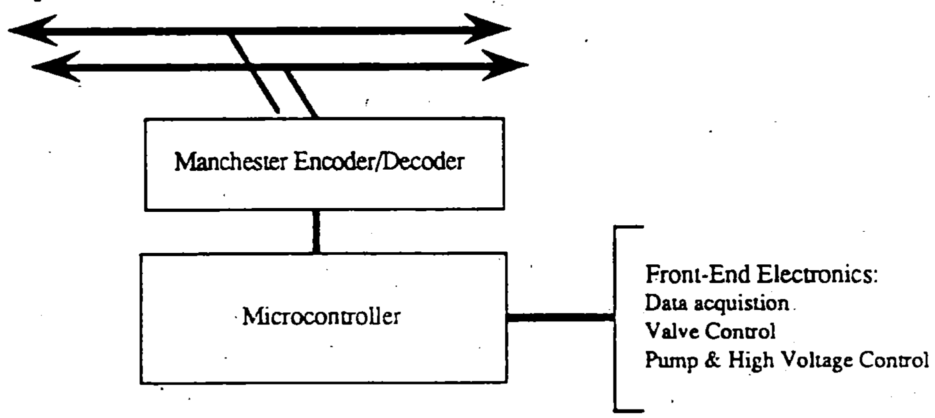
Ironically, the system was designed with redundant electronics but only the primary side has the sensor signal conditioning and the secondary side the low voltage supply for the motor control. Therefore, the two are not truly independent nor redundant and the attempt only further confuses the situation.

Mechanically, the problems in the existing system stems from the arrangement or configuration of the various subassemblies. Many problems are associated with the long evolution of the design; for example, in the very first version of this tool the pump was driven directly by a single phase AC motor. The sensors and D.A. electronics and the pump, motor, and valves were assembled as a single tool section. This design did not perform well and was abandoned. The current pump design works quite well but when implemented the pump system grew considerably in size and required the addition of a high voltage power supply. A single tool section could no longer house the combination and the the pump/valve system was removed to form a second tool section. The vertical arrangement of the subassemblies has severely complicated the design of the tool connections requiring 3 high voltage feedthrus. More on this subject will be discussed in Tool Layout and Tool connections.

**Solutions:**

The basic node will be comprised of a microprocessor based controller. Data and commands will be exchanged within the tool along a two-wire serial data bus. Rather than use an RS-232 or NRZ (non return to zero) method, we will incorporate the Manchester encoder/decoder for improved noise immunity and error detection. The Node located at the top of the sonde will also house and control a differential FSK (frequency shift keying) transmitter/receiver. The FSK will handle communication over the wireline with the surface. The combined technique should be capable of operating in a high noise environment at data rates substantially higher than required for this sonde.

Commands will be transmitted in full-duplex mode where the receiver echoes a data frame back to the sender for comparison. If errors are detected by the Manchester encoder (at either location) or the data does not compare bit for bit, the instruction is retransmitted. Operations will be redundant, i.e. will require several command or data frames in proper sequence before execution.




Figure#4: Conceptual illustration of a typical Node.

The Manchester encoder/decoder is particularly suited to this application due to the structure of the data frame. The frame can be configured for up to 28 bits addressing up to 32 nodes. The frame (if configured similar to MIL-STD-1553) contains 4 functions: Sync, Address, Data, and Parity. The Manchester is a self timing device, the clock is imbedded in the data. The Sync begins the frame and identifies it as either a command or data word. The address would, in our application, identify either a particular node or transducer depending on whether the Sync indicated the frame was command or data, respectively. Data is self explanatory; in a command frame it would contain the instruction, in data frame it would contain the binary value for a given transducer. The parity bit is used for error detection. This provides for inherently reliable data transfer.

The Manchester has been proven in the downhole environment and is the basis for the DMT digital televiewer data transmission. The device was originally designed to network instrumentation in military jet aircraft.

### Additional Modifications:

Power supplies for the valves and electronics will require redesign. Downhole supplies will be replaced with wide input range DC-DC converters. Traditionally, the wide variation of voltage at the cablehead, caused by the wireline resistance and changes in the current, was too severe for a voltage mode method to be used. Switching power supplies have recently become available with input ranges as wide as 125-375 volts DC which should overcome that problem.

## Permeability:

### Background:

The tool, to date, does not have a flowmeter nor is there provision for one. A flowmeter is essential for permeability measurement and a monitoring aid the operator really shouldn't have to do without.

Initially there was discussion of using a pulse decay method for permeability measurement which wouldn't require a flowmeter. In a pulse decay test a volume of fluid is injected or withdrawn from an isolated interval creating a pressure pulse. The pressure is monitored until the interval returns to hydrostatic. The data is then compared to a type-curve and the permeability estimated. Unfortunately, the combined effects of the following problems negate this method:

a) The peak value of the pulse must be known. Because the motor causes noise in the data and the data stream does not recover until several seconds after the motor is shut off, this is not possible.

b) The pump system is effectively constant horsepower. Therefore, the maximum pressure drawdown is inversely proportional to the max. flow (and effected secondarily, by the system pressure drop). In other words, in a tight formation the pressure is at the maximum (350PSI) and the flow relatively low. In the other extreme, the flow is at maximum (~1GPM) and the interval pressure relatively low except that the measured pressure is offset by the system pressure drop. This means that the peak pressure will vary from zone to zone.

c) The pump is difficult to control, taking several seconds to come to speed and several to cease. The pump cannot be turned on and off quickly. Thus, there is a wide variation in the volume of fluid pumped in a short duration test indicating that a constant volume method is not feasible. Furthermore, because the volume varies, the depth of penetration or influence will vary, which will effect recovery.

d) The method dictates that the recovery must be several times longer than the rise-time of the pulse and that pressure data be recorded at a rate such that the curve is well characterized (the data rate is approx.4 seconds per measurement). Therefore, the conventional pulse-decay test is usually only attempted in low permeability regimes where the formation recovery will be slow. The Catch-22 is that in zones where we can reasonably expect to recover a sample the pulse-decay test is inaccurate or impossible.

## Solution:

We intend to add a turbine flowmeter to the main data acquisition cartridge in the redesign. We have selected a turbine type because it is most easily integrated into the system. Ultrasonic and Mass flow designs are attractive because of the ability to pass slurries but these transducers would require a great deal of support electronics. In addition, a rather expensive custom design would be required for the Mass flowmeter in order for it to be fit in a logging tool. There is some debate about turbine flowmeters, the main concern being filtration and turn down ratio (or resolution). The latter can be improved by using a RF (radio frequency) pickup as opposed to the more typical magnetic pickup (which impose a load on the rotor). An example would have a range of 0.02-1.3 GPM. The filtration problem can be reduced by using tungsten carbide bearings. Manufacturers state that 100 microns would be acceptable for long life. We will need to run verification tests in the lab before proceeding. *Flow Technology* and *Hoffner Controls* both offer high quality products with which we have had good success in the past.

## Sensors:

### Background:

There are three types of sensors present in the system: Pressure, Temperature, and Ion Electrodes. The pressure transducers are the strain-gauge type and tend to have a fairly large temperature drift that should be addressed. Bear in mind though that we are not as interested in the absolute pressure but rather the change in pressure during an experiment which de-emphasizes the point. The temperature transducer is a platinum RTD and performs well.

The Ion electrodes are the problem. There are 4 electrodes: ph/Cl., Na., Ca., and a half-cell reference. The electrodes are filled with a silver salt or Caromel solution in contact with a membrane sensitive to the element being measured. The electrode output is compared to the reference electrode. Unfortunately the electrodes are extremely fragile, foul easily, and must be pressure compensated. The pressure compensation bladders tend to leak and rupture easily. Dr. Frolich (LDGO) suggests that these types of sensors are difficult to calibrate and use accurately in the laboratory due primarily to extreme temperature and pressure sensitivity. Their use also seriously complicates mechanical design. An attempt at a downhole application is probably a waste of time.

### Solution:

The Ion electrodes will be, for the time being, abandoned. We will instead use a fluid conductivity measurement similar to those used in oceanographic CTD instruments. The fluid conductivity sensor is a simple and rugged device which have been used reliably in the field for years. The temperature probe will need to be located with the conductivity probe for proper compensation.

The fluid conductivity, temperature, packer and interval pressure transducers will be combined with the flowmeter, data acquisition and node electronics to form a new tool section. The section will be called the Sonde Measurement cartridge and will be located between the Pump/Motor and Sample Bottle cartridges. This change in location will shorten the sample fluid circuit and greatly simplify the tool connections between cartridges.

If, in the future, additional measurements are desired, an Auxiliary Measurement cartridge could be built and, again, via the modular approach, installed in the system without additional modification. Future measurements might be, for example, fluid density or differential pressure measurement (for improved resolution) or, of course, the revival of chemical measurement. We; however, do not wish to commit to additional measurements at this time, preferring to concentrate on the primary system.

## Filtration:

### Background:

During Leg 133, as I indicated in my brief in Townsville, the main filter assembly clogged preventing further testing (hole 816-C). In fact, the filter eventually collapsed allowing slurry to invade the system. This was compounded by problems with the the By-Pass Intake.

The By-Pass intake consists of a valve that connects the pump intake with the annulus and is only opened during packer inflation.. The bulk of the fluid used to inflate the packers is drawn from the interval while the By-Pass is intended to allow the packers to be fully inflated even if the interval is impermeable. Note that without the By-Pass, an operator would not be able to differentiate between a permeable zone and a poor packer seal. Unfortunately, there was no attempt to filter the By-Pass intake which, incidentally shares porting with the pump discharge and packer deflation lines. Therefore, the failing of the packers to deflate completely can be partially attributed to reduced flow through the port.

### Solution:

The main filter is a three-fold problem. Firstly, the filter area needs to be increased. Secondly, the allowable differential pressure rating of the filter element must be increased to prevent collapse. Third, the location of the filter must be changed. Right now the filter is housed in a small pressure case above the packers. As fluid is pumped through the system the filtrate is deposited in the pressure case until, in the case of 816-C, the case is completely filled and flow choked. The pressure case could be lengthened which would allow for a longer filter (and more filter area) but that would also increase the "dead volume" inhibiting flushing.

The best solution is to locate the filter in the interval between the packers. That way the filtrate would be left where it started, in the interval, and the "dead volume" is removed. This will require either a custom filter or more likely the modification of an existing filter. I am still in the process of selecting a manufacturer. *Norman Filtration* has an extensive line that we have used in other downhole systems successfully.

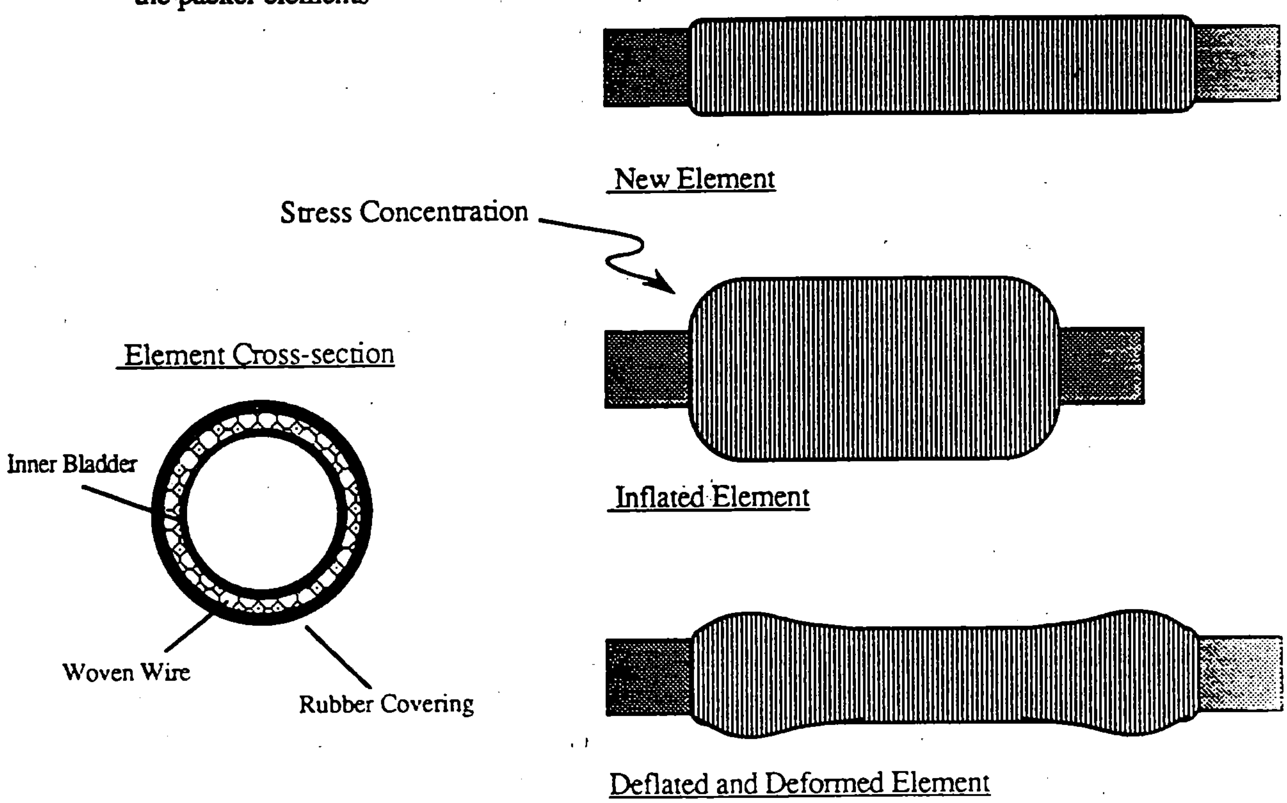
With regards to the By-Pass Intake, obviously a filter must be added. In addition, the port must be isolated from all other fluid lines to remove the possibility of a clogged filter preventing packer deflation.

## Packers:

### Background:

When the tool was retrieved from hole 816-C the packers had not fully deflated and became stuck in the BHA (bottom hole assembly). The tool was pulled free of the packers by use of the shear pin assembly and brought on deck. The packers were later retrieved from the BHA where they had become wedged. The shear pin assembly is a safety device intended to allow retrieval of the main body of the tool in the event that the packers become stuck in openhole or fail to deflate properly.

As mentioned in Filtration section above, the packer failure maybe due in part to the By-Pass port being clogged but, upon inspection at the surface, deformation was noted in the packer elements




Figure#5 Element Construction and typical deformation at stress concentration.

TAM International, Lamont, and shipboard tests indicate the the packer elements will deform if inflated beyond a certain point. The post-deflation diameter is a function of the diameter to which the packer was inflated, how many inflation cycles the packer has been subjected to, and the individual packer element (there is some variation in manufacture). The point at which the packer deforms is also dictated by inflation cycles and the individual element. This deformation is caused by a stress concentration at the edge of the binding where the bend radius is most severe. In the packers we have tested, the elements will, in a free or unconfined inflation test, reach a final diameter of ~13 inches O.D. +/- 0.5 2 350PSID. Upon deflation, the elements typically return to ~4.25 inches O.D. +/-0.25 with a new element being 3.65 inches O.D. In actual use, we estimate that the packers will operate in holes up to 12.5 inches with TAM Inter. guaranteeing performance to 10.5 inches at full rated temperature.

## Solutions:

There has been some discussion about reversing the pumps to draw the packer elements down hydraulically. We will need to run some tests in the lab as soon as possible. I had intended on presenting that data here but the sea freight was delayed leaving Australia and we have just recently received the tools. TAM Inter. suggests that this will not work 100% and I agree but there is a good possibility that it will be all that is required. The I.D. of the drill pipe even with the joint upsets is not the main restriction, the problem is in the BHA. After the 816-C tests, the elements were approx.4.3 inches at the bindings and the middle was ~4.1-4.2 inches. That means that the contact area was along almost the entire length of the elements. If the packer were pumped down, the non-deformed middle portion of the element would be drawn in so that even if the deformed area at the bindings remain oversized, the contact area and resulting friction would be reduced dramatically.

Another more complicated approach would be to mechanically pull the packers back to shape. This has already be done in the case of the drill stem straddle packer that uses springs to pull the lower binding back. In TAM's design, the upper binding is fixed to the packer mandrel while the lower binding is free floating and allowed to move up and down the mandrel. This is done so that, as the packer expands during inflation, it is allowed to shorten until set. Post -deflation, if a force were applied to the lower binding, pulling it down, the packer element would be stretched back to shape. In the wireline packer a spring would not be practical. Instead a hydraulic force would be applied by designing a piston/cylinder arrangement into the lower binding. The pump would then be use to pump the binding into place. This option would obviously be avoided unless deemed necessary by the results of the drawdown test mentioned above.

As a third option. assuming clearance from ODP/TAMU, we plan to design a Go-Devil connection to the drill stem straddle packers. This would be used in lieu of the high expansion packers. This option would be taken only in Reentry holes where the drill stem straddle packer was already scheduled and/or the loss of a high expansion packer assembly would be detrimental to future operations.

### Additional Modifications:

TAM International used a standard 48 inch packer element for this tool. When fully inflated the wall contact is only about 15 inches long. This may not provide an adequate seal in some situations. We intend to replace the elements with a 60 inch elements from TAM. This will require machining new packer mandrels and piping only.

## HVPS:

### Background:

The downhole high voltage power supply converts ~400 volt DC power into the 3 phase 330 volt AC that powers the motor. Four of the seven conductors of the wireline are used to transmit the DC power. On leg 133, hole 812-B the supply failed on deck. The first failure occurred when the tool was rigged. A high voltage connector shattered in the tool connection between the electronics and the pump sections. The two subsequent failures were caused by wires broken whilst repairing the high voltage connector. The HVSP is poorly constructed and is not rugged enough for downhole service.

The location of the Ion sensor chamber above the supply compounds the problem by requiring 5 hydraulic lines to pass through the HVPS pressure case. Worse, because the ion sensors must be serviced before each logging run and the HVPS cartridge removed to access the sensors, there is a high risk of flooding the HVPS pressure case. The pressure integrity of the tubing cannot be tested to the full 10KPSI rating with the current arrangement.

The power supply causes excessive noise on the wireline. The AC output of the power supply is a square wave not a sinusoid. The square waves produce harmonics that interfere with data transmission. High fluctuations in motor current and poor power filtering at the surface add to the problem.

### Solutions:

I have already considered and abandoned two alternative designs for this power supply. High voltage D.C. power is extremely dangerous. The current system operates at 500 VDC at the surface which could be fatal in the event of an accident. AC power, at comparable voltage, is considered safer than DC power because of muscular response. TAM International built their second generation wireline packers using a 3 phase AC surface supply but that system was design to run on short wirelines. Unfortunately, in order to provide enough power on a 30,000 ft wireline it is estimated that, with 6 out of 7 conductors used (2 conductors per phase), the surface voltage would be 880 VAC. The surface voltage is higher, even though more conductors are used, because the motor requires 3 phase power and the voltage drop on 2 conductors is twice the drop on 4 conductors. There would be little or no improvement in safety provided by this approach; furthermore, the higher operating voltage increase the chance of arcing the cablehead or wireline. It should be noted that tools requiring high power, such as the Schlumberger RFT, have a reputation for finding leaks or weak spots in wireline insulation.

The second alternative considered was the use of a sinusoidal downhole supply with DC power transmission. This would cut down on cable noise since noise from a 60 Hz sine output could be filtered easily. This type of design; however, is basically a large power amplifier that would be much too inefficient.

**Conclusion:**

The design concept of the current HVPS will be retained. In restructuring the sonde, the HVPS will be moved to the top position in the sonde and directly attached to the modified pump/motor section to form the HVPS/Pump cartridge. The pump section will have been shortened by moving the bottle valves but the packer control valving will remain with the motor and pump. This change eliminates the hydraulic lines in the HVPS pressure case and allows for more electrical feedthru's in intermediate bulkhead (between HVPS and pump/motor) which will simplifying motor speed sensing and packer valve control. This also simplifies tool connections by eliminating the fragile high voltage connectors.

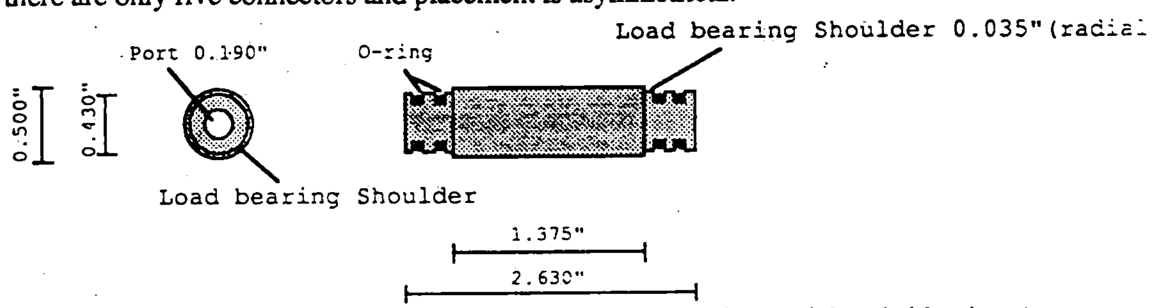
The electrical hardware of the HVPS will need to be completely rebuilt.
There will be the addition of the Node electronics and the front-end electronics for packer valve control, motor control, and motor speed sensing. Improvements to the noise problem can be made by adding a capacitor to dampen the wireline, but again, the data transmission method must be improved.

## Tool Layout and Connections:

### Background:

Figure #7 illustrates the layout of the existing tool. The layout of the various functions directly effect the problems of sample contamination (as previously indicated) and tool connection. The tool connections are a critical point in the design requiring multiple electrical and hydraulic interconnections. The existing design is not rugged enough for offshore use. The internal connectors are much too fragile and difficult to assemble. On leg 133, hole 812-B, the first attempt to rig the tool was done horizontally (by suggestion of TAM Inter.) to avoid damaging the electrical connections. Unfortunately, excessive bending in the tool string shattered one of the high voltage connectors. Note that in standard practice a logging tool of this length would not be rigged horizontally because of safety considerations. In the second two attempts at that site the 4 sections of the tool were rigged vertically. Because the electrical connections must be made manually, this is difficult to accomplish and dangerous for the operator. Even in good weather its impossible to prevent 15 ft. and some 150 lbs. of tool from flailing around. Slack in some of the wires is less than 1 inch. In addition problems, the 9-pin solenoid connection is poorly constructed without an outer sheath for mechanical protection or waterproofing and high voltage feedthrus are extremely fragile. Note that cracked insulation typically results in a short circuit that causes permanent damage to the HVPS.

The problem is compounded by the design of the hydraulic connections or bulkhead connectors. Besides the alignment problems during assembly, these connectors must support the entire hydrostatic load (100KLbs. @ 10KPSI with a 3.5 inch O.D. sonde) because the connection is at atmospheric pressure (see figure #6). Connections are subjected to bending moments caused by ship heave (with packers set) and bridge bashing. Failure could result in collapse of the connection resulting in loss of the lower portion of the tool string. The connection between the HVPS and the motor is particularly dubious as there are only five connectors and placement is asymmetrical.




Figure#6: Bulkhead Connector from the lower tool connection (axial and side views).

### Solutions:

In the existing design there is a collar on the upper half of the tool connections that secures the assembly. This collar is free to rotate and floats in the crossover containing the connectors. The collar has a female thread. The upper half of the connection is not captive or guided to the lower half during assembly. Schlumberger and most other logging companies design for captive connections so that during assembly the weight of the upper section can be set on the lower section and tool cannot swing uncontrollably. In addition, the internal connections are self aligning and make up automatically as the joint is tightened.

In redesigning the tool connections 3 criteria are dictated; the joint must make up easily and safely, all connections must be made automatically, and the joint must be rugged and the load supported by bulkheads. In order to achieve this the number of hydraulic connections must be reduced. Currently the upper connection contains 5 hydraulic lines while the lower contains 9 lines. This can be reduced to 2 connections supporting all functions. One will be suction, the other packer control (see Fluid paths,Figure #8). There is the added benefit of less potential for leaks with fewer connections. The hydraulic connections would consist of a captive tube which inserts into a O-ring sealed receiving port. The hydrostatic load would be supported by the bulkheads and pressure cases rather than the small connector tubes. Signal and other electrical connections would be made using commercially available connector inserts similar in method to Schlumberger's; however, by moving the position of the HVPS to combine with the Pump/Motor, the high voltage connections will be eliminated altogether (compare figures #7 and 8). Schlumberger's joint design uses a captive collar with a male thread that tightens into the female thread of the pressure case.

## Pumps and Packer Control:

### Statement:

There are a number of minor problems here. One modification that will carry through to all cartridges is construction of better chassis. The chassis, where present, are poorly designed, difficult to work with, and flimsy. For example, the oil pump is mounted to the motor with only one screw.

The water cylinder will be partially rebuilt removing incompatible components (aluminum and water don't mix). The packer control pilot valve or dump housing will be modified to use the oil pump pressure to operate it rather than the water pump pressure. This will allow higher spring forces to be used on the pilot spool, decrease the chance of particulate contamination preventing operation, and allow larger ports for faster deflation. The packers will still be inflated by water. The valves that control the packer control pilot and the valves that control the By-Pass and other functions will be replaced by higher quality *Circle Seals* balanced poppet solenoid valves

## Surface Power and Interface, software:

**Statement:**

The system is currenty operated by a small Compac computer. This will not be used in the new system, prefering to use the more powerful IBM PC/AT that is used to control the D.M.T. Digital Televiewer. This will allow a reduction in the number of machines that must be supported at sea. This, being a faster machine, will also allow for graphical display of data in realtime. The packer control and acquisition software will need to be completely rewritten and an hardware interface built to utilize the new data format and electronic designs.

The surface power supply supplied with the system will probably not be used in the future. Instead, we will use the *Sorenson* 1.8KW supply that has already been purchased for another project.

## Work Statement and Budget:

We plan to build and test one complete tool. If, after shipboard testing, the tool meets expectation, additional tools could be constructed at substantially reduced. We will require two engineers to complete this project in a reasonable time period. The period as planned is 9 - 12 months. One engineer will specialize in electronics, the other mechanical and hydraulic design. Most of the work will be done at Lamont with the exception plating, heat-treating, and some machining. Lamont has a complete and capable machine shop on campus.

In regards to electronics, some equipment will be needed for software development for the microprocessors. Since this equipment tends to be expensive and will only be needed temporarily, it will be rented rather than purchased.

The budget is prepared somewhat differently than in the usual proposal. The project requirement or base cost is the average between the projected minimum and maximum costs. Note that no overhead will be charged for individual components that make up the tool. Exception are spare parts and rentals.

Wireline Packer Budget

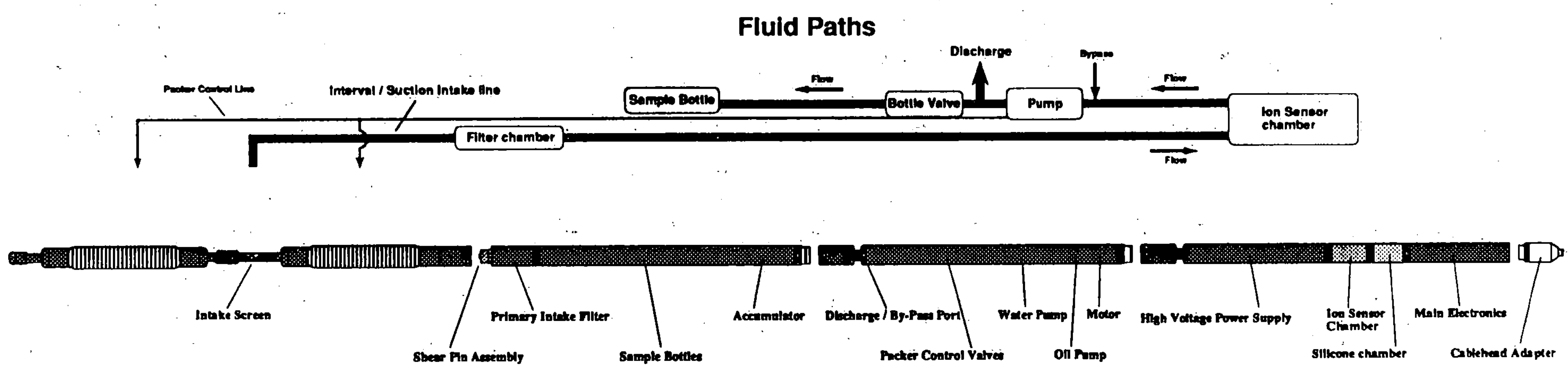
| Expendature: | Type: | Units(min.) | Units(max.) | Cost $(min.) | Cost$(max.) | Total Line(min.) | Total Line (max.) |
|---|---|---|---|---|---|---|---|
| Section#1(Node#1):FSK Data Transmission | Electronic | 1 | 1 | 2000 | 3000 | 2000 | 3000 |
| Section#1: Cablehead, Cable Tension, Centralizer | Mechanical | 1 | 1 | 5000 | 6000 | 5000 | 6000 |
| Section#2(Node#2): Valve/Pump Control | Electronics | 1 | 1 | 1500 | 3000 | 1500 | 3000 |
| Section#2(Node#2):HV power supply | Electronics | 1 | 1 | 1000 | 1500 | 1000 | 1500 |
| Section#2: Inflation control valves | Mechanical | 4 | 5 | 1000 | 1200 | 4000 | 6000 |
| Section#2:Chassis | Mechanical | 1 | 1 | 1500 | 2000 | 1500 | 2000 |
| Section#2:Pump (mostly scavenged) | Mechanical | 1 | 1 | 1000 | 2000 | 1000 | 2000 |
| Section#2: Crossovers/Tool Connections | Mechanical | 1 | 1 | 4000 | 7000 | 4000 | 7000 |
| Section#2:Pressure Case (HV/pump control) | Mechanical | 1 | 1 | 2000 | 4000 | 2000 | 4000 |
| Section#3(Node#3): Aux. Measurements | Not scheduled | 0 | 0 | 0 | 0 | 0 | 0 |
| Section#4(Node#4): Measurement Sonde | Electronics | 1 | 1 | 2000 | 3000 | 2000 | 3000 |
| Section#4: Flowmeter | Sensor | 1 | 1 | 1000 | 2500 | 1000 | 2500 |
| Section#4:Pressure | Sensor | 2 | 2 | 1200 | 2400 | 2400 | 4800 |
| Section#4:Fluid Conductivity | Sensor | 1 | 1 | 500 | 1000 | 500 | 1000 |
| Section#4:Temperature | Sensor | 1 | 1 | 250 | 500 | 250 | 500 |
| Section#4: Pressure case | Mechanical | 1 | 1 | 1500 | 3000 | 1500 | 3000 |
| Section#4:Crossovers/Tool Connections | Mechanical | 1 | 1 | 2500 | 5000 | 2500 | 5000 |
| Section#5(Node#5): Valve controls | Electronics | 1 | 1 | 2000 | 3000 | 2000 | 3000 |
| Section#5: Pressure cases | Mechanical | 1 | 1 | 3000 | 6000 | 3000 | 6000 |
| Section#5:Valves | Mechanical | 8 | 8 | 500 | 1200 | 4000 | 9600 |
| Section#5:Bottles | Mechanical | 8 | 8 | 1000 | 1500 | 8000 | 12000 |
| Section#5: Crossovers/Tool Connections | Mechanical | 1 | 1 | 2500 | 5000 | 2500 | 5000 |
| Section#6: 60" Packer elements | Mechanical | 4 | 4 | 1500 | 2000 | 6000 | 8000 |
| Section#6: Packer Mandrels | Mechanical | 2 | 2 | 1000 | 1500 | 2000 | 3000 |
| Section#6: Filter System | Mechanical | 2 | 2 | 1000 | 3000 | 2000 | 6000 |
| Misc Parts: Fittings/Tubing | Mechanical* | 1 | 1 | 1500 | 3000 | 1500 | 3000 |
| Misc Parts: Small hardware | Mechanical* | 1 | 1 | 1000 | 1500 | 1000 | 1500 |
| Misc Parts: Spare seals | Mechanical* | 1 | 1 | 1000 | 1000 | 1000 | 1000 |
| Development Equip. | Electronics* | 1 | 1 | 4000 | 8000 | 4000 | 8000 |
| | **Equipment subtotal:** | | | | | 69150 | 120400 |
| Equip. Overhead @ 42% | | | | | | 3150 | 5670 |
| Electronics Engineer | Salary | 9 | 12 | 3500 | 4500 | 31500 | 54000 |
| | Fringe @27% | 9 | 12 | 945 | 1215 | 8505 | 14580 |
| Mechanical Engineer | Salary | 9 | 12 | 3500 | 3500 | 31500 | 42000 |
| | Fringe @27% | 9 | 12 | 945 | 945 | 8505 | 11340 |
| Salary subtotal | | | | | | 80010 | 121920 |
| Salary Overhead @ 42% | | | | | | 33604 | 51206 |
| Salary total | | | | | | 113614 | 173126 |
| | **Best Case/Worst case Tally** | | | | | $185,914 | $299,196 |

| | | | |
|---|---|---|---|
| **Project less Overhead** | $195,740 | plus/minus | $56,641 |
| **Overhead (42%):** | $46,815 | plus/minus | $10,061 |
| **Total w/Overhead:** | $242,555 | plus/minus | $66,702 |

* denotes Overhead applies

# Existing Wireline Packer Layout:

**This figure illustrates the path of the sample fluid flow and the configuration of basic components in the existing system. The Sonde is approx. 45 feet overall, fluid path from Interval to Bottle is approx. 55 feet.**




**Straddle Packers:**
This section consists of the upper and lower packers.

**Sample Bottle Section:**
This section contains the 4 sample bottles, and the accumulator for the pump/motor section. The lower pressure case contains the primary filter.

**Pump / Motor Section:**
This section contains the motor, Oil pump, hydraulically driven water pump, and the packer / sample bottle control valves.

**HVPS and Main Electronics Section:**
From top to bottom, this section is comprised of 4 pressure case. The upper case contains data acquisition and valve control electronics. The middle two cases contain the silicone oil filled sensor pressure compensator and the Ion sensor chamber, respectively

The lower pressure case contains the High Voltage power supply.

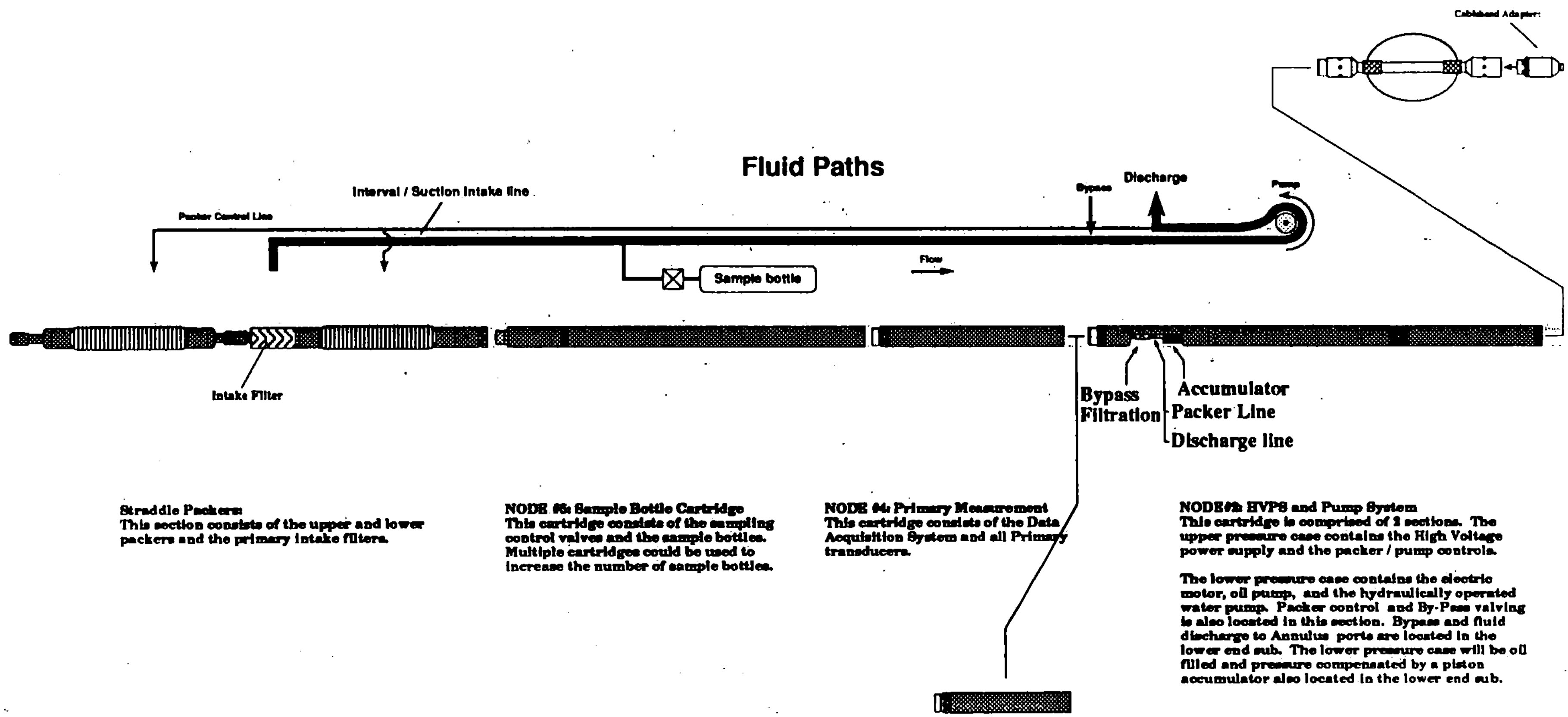
Figure #??

Not to Scale

# Restructured Wireline Packer layout:

**This figure illustrates the path of the sample fluid flow and the new configuration of basic components. The design is optimized for minimum tubing length and fluid volume before the sample bottles, and minimum hydraulic and electrical interconnection between cartridges.**

**NODE #1: FSK Transmission / Centralizer**
**This cartridge consists of the FSK Transmission system and will include a head tension measurement. The bow spring centralizer will stabilize the sonde when the packers are set and the cable is slacked.**




**Straddle Packers:**
**This section consists of the upper and lower packers and the primary intake filters.**

**NODE #5: Sample Bottle Cartridge**
**This cartridge consists of the sampling control valves and the sample bottles. Multiple cartridges could be used to increase the number of sample bottles.**

**NODE #4: Primary Measurement**
**This cartridge consists of the Data Acquisition System and all Primary transducers.**

**NODE#2: HVPS and Pump System**
**This cartridge is comprised of 2 sections. The upper pressure case contains the High Voltage power supply and the packer / pump controls.**

**The lower pressure case contains the electric motor, oil pump, and the hydraulically operated water pump. Packer control and By-Pass valving is also located in this section. Bypass and fluid discharge to Annulus ports are located in the lower end sub. The lower pressure case will be oil filled and pressure compensated by a piston accumulator also located in the lower end sub.**

**NODE#3: Auxiliary Measurement**
**This cartridge could consist of the fluid chemistry, fluid density, Differential Pressure Transducers, and/or other experiments.**

Figure #??

Not to Scale

ANNEXURE II

# Status of the Shipboard Computer System February 1991

Prepared by the ODP Technical Service Group

Status of Shipboard Data Integration

This document reviews recent developments in the shipboard computer systems. In addition special attention is given the those areas relating to the integration of core and log data.

# 1. Current Status of the Shipboard Computer System

## 1.1. VAX

### 1.1.1. New Hard Disks

Three 1.2 gigabyte hard disk drives have been sent to the ship. One drive is in use as a DATA disk, the second as a DATA backup disk and the third as a spare. SCSI bus technology was used resulting in a very cost-effective solution to the disk space problem we were experiencing.

### 1.1.2. Multinet Software Installed

In order to establish an easy and reliable data transfer path between the BRG computer systems and the shipboard VAX cluster, the Multinet TCP/IP networking package was installed on leg 134.

TCP/IP protocols are pervasive in ethernet-based networking and they allow a variety of hardware platforms to readily share network services. The shipboard VAX is now capable of transferring files to and from the BRG Masscomp, Macintosh and VAXstation 3200 computers. This link is also used to support the digital televiewer installed on leg 134.

### 1.1.3. BRG VAXstation 3200 Installed

After testing at ODP Headquarters, the BRG VAXstation 3200 was shipped to the Resolution and installed in the Downhole lab. The system is networked to the shipboard VAX system and is in use for FMS data processing on a routine basis.

## 1.2. PC Compatibles

The PC compatibles have been upgraded to accommodate the increased demand for processing power on board the ship. After a careful evaluation of available hardware and software, the following components have been purchased for installation onboard the ship.

### 1.2.1. 386 Motherboards

- Full 80386 CPU
- 25 Megahertz clock
- Four Megabytes RAM
- 80387 Math Co-processor
- Microsoft-compatible Bus Mice

1.2.2. **VGA Monitors**

- 14" screen
- 512Kb video memory on board

1.2.3. **3.5" HD Floppies**

This floppy disk format will become the shipboard standard. Its use will allow the easy transfer of data between the Macintosh and PC compatible systems.

1.2.4. **MS Windows 3.0**

- Graphical User Interface
- Multitasking
- Virtual Memory
- Compatible with Existing Software
- Network Compatible with Shipboard Internet

1.3. **Macintosh**

1.3.1. **LaserWriters**

- LW IInt's upgraded to IIntx
- QMS printers replaced with IIntx printers (in progress)
- LaserWriters Memory Upgrade

  Memory upgrades to four megabytes minimum.

1.3.2. **Mac Memory**

- Eight Megabytes in Most Systems

1.3.3. **SE's Upgraded to SE30's**

This motherboard replacement will allow the Mac SE computers to utilize all capabilities of the the Mac Operating System version 7.x when it is released.

1.3.4. **Mac II MMU Upgrades**

This Memory Management Chip (MMU) will allow the Mac II computers to utilize all capabilities of the the Mac Operating System version 7.x when it is released.

1.3.5. **New Paleo Lab Macs**

New Macintosh computers will be installed in the shipboard Paleo lab for the purpose of collecting biostratigraphic data in a computer database. Installation is anticipated for early summer.

1.4. **Spreadsheet Selection in Progress**

The selection of a spreadsheet for use on the shipboard microcomputers is currently in progress. Wingz, from Informix and Excel from Microsoft are under consideration. Both candidates run equivalently on the Macintosh and PC compatibles and are able to share data files transparently.

The final selection will be made in the near future and licenses will be purchased for use throughout the labstack. A few licenses for other popular spreadsheets will be available for special situations.

## 2. Current Status of Shipboard Data Acquisition

### 2.1. Physical Properties

#### 2.1.1. Multi Sensor Track

- Software Stabilized

The Multi Sensor Track software received a major upgrade during the Leg 134 portcall in Townsville, Australia. The system is completely functional at this time. Data from the system is uploaded automatically to the VAX where it is manually processed to add sub-bottom depths. The final MST data files reside on the file server where they are available to all shipboard systems.

- Natural Gamma Sensor

Plans are in progress to add a natural gamma sensor to the MST. This measurement will allow the CoreLab data to be more readilycorrelated with the downhole logging data.

#### 2.1.2. Index Properties

- Spreadsheet User Interface

A Macintosh computer is installed in the Paleo lab and guidelines have been established by the ODP Database group for Physprops spreadsheet interfaces. The need for a spreadsheet interface for this program has been identified as a top priority by the ODP Computer Software Priorities Committee. The upgrade has been requested for Leg 136.

### 2.2. Sedimentology

#### 2.2.1. Computerized VCD

A Macintosh-based VCD program will be installed on Leg 136.

#### 2.2.2. Digital Core Imaging System

A prototype digital imaging system was installed on the Resolution on leg 133. Feedback from this shipboard trial is being used to develop the system further on shore.

### 2.3. XRD/XRF

- **Macintosh Spreadsheet Templates**

  Excel Templates were prepared during the course of Leg 134 for use in analyzing XRF/XRD data. A Macintosh computer was installed in the lab for this purpose and the spreadsheets are currently in routine use.

- **Xray Data on the Fileserver**

  The xray spreadsheets and the ASCII files output from the spreadsheets are routinely uploaded to the VAX fileserver for access throughout the labstack.

### 2.4. Geochemistry

No changes made or anticipated in this area. ASCII data files from the Chem Lab datasets are automatically stored on the file server for access throughout the labstack.

### 2.5. Paleontology

- **CheckList**

  The version of CheckList developed for ODP is currently in final testing on shore and should be ready for installation on the ship in the near future.

- **Bug In**

  A customized version of the Bug In program developed for ODP is being prepared. A prototype of the program should be ready in late February for testing. Final installation is scheduled for early summer 1991.

## 3. Data Processing Software

### 3.1. KaleidaGraph and Grapher

The KaleidaGraph program (on the Macintosh) and Grapher (on the PC compatibles) are currently on use aboard the ship for the production of final publication quality plots.

### 3.2. DataDesk Professional

The need for data analysis tools beyond the scope of spreadsheet programs has been identified on board the ship. The term Exploratory Data Analysis (EDA) is often used to describe a suite of integrated analytical tools which allow large volumes of data to be viewed in powerful and intuitive ways.

EDA packages typically include graphics, statistics and database functions in a way that maintains strong linkages between the different data views and facilitates an intuitive investigation of large datasets.

The DataDesk Professional program has been installed on all shipboard Macintosh computers to provide this function. No equivalent program has been found for use on the PC compatible systems, however we continue to look and will evaluate candidates as they appear.

### 3.3. COREPAC Software Evaluated

The COREPAC software package was installed on the shipboard VAX system for evaluation. The overall feeling was that the program had some very attractive features but could not be recommended for purchase without being customized to meet our specific needs.

## 4. Progress on the Integration of Core and Log Data

### 4.1. Background

The JOI workshop on Shipboard Integration of Core and Log Data, held in August 1990, formalized the need to unify the logging and core laboratory datasets. A strawman strategy was proposed in the effort to stimulate further discussion on the subject and to begin laying the groundwork for a solution to this problem.

The following sections review the work accomplished towards this goal and highlight several areas that may present problems.

### 4.2. Leg 134 Experiment

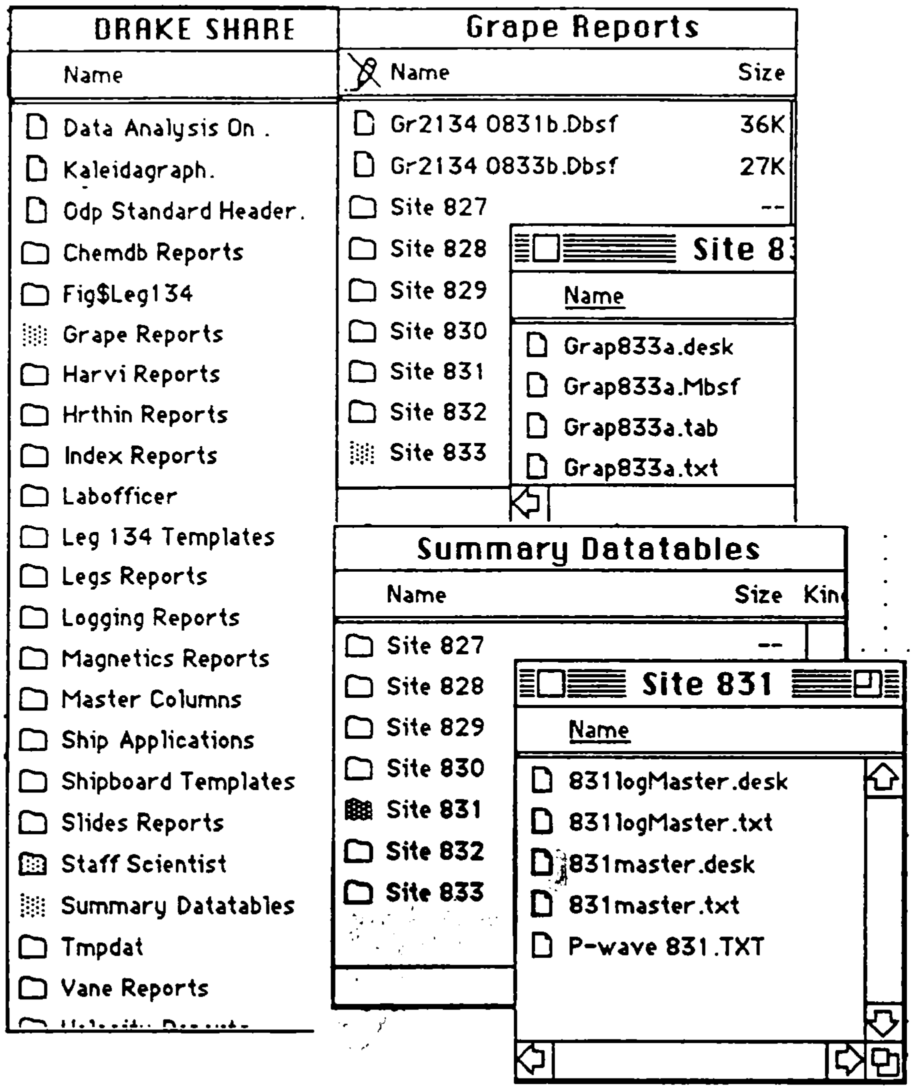
The discussion which follows relys heavily on experience gained during the course of ODP leg 134. On this cruise an effort was made to push the limits of the hardware and software (and personnel) currently onboard the ship and see what was possible in the way of data integration at this time.

The experiment involved collecting and processing data from every source possible and combining the data into Summary Data Tables. These data files were stored on the fileserver for use throughout the labstack.

The data tables and figures resulting from this effort are in high demand for post-cruise analyses and the 134 scientific party felt the experiment was a success.

## A View of the Shipboard Fileserver

Status of Shipboard Data Integration



### 4.2.1. Lab-specific Datasets

The lab-specific datafiles were made available on the fileserver in two forms:

- Tab-delimited ASCII, which is readily uploaded to any spreadsheet or graphics package.

- DataDesk Professional binary files which are used for exploratory data analysis as described in the Data Desk section above.

These datafiles represented the "best efforts" of shipboard scientists to filter and clean the data from their labs. These datafiles comprised the individual components of the Summary Data Table described below. All the lab-specific data files contain sub-bottom depths calculated from the CORELOG dataset.

The unprocessed raw data were stored in the formal ODP datasets as usual for archiving by the ODP Database Group.

### 4.2.2. Logging Data

The downhole logging data was routinely received in ASCII format and stored on the fileserver for shipboard use. In one case the logging data was added to the Summary Data Table for cross plotting, however in most instances, the data was maintained separately due to the different depth references used by the two datasets.

### 4.2.3. Summary Data Tables

The lab-specific datasets were merged to form a Summary Data Table for each site. Summary Data Tables contained:

- A standard ODP Sample ID for each record

- A single reference depth for each record

- Up to 60 columns of data from the various labs.

Both tab-delimited ASCII and DataDesk Professional versions of the Summary Data Tables were available on the fileserver.

Several characteristics of the Summary Data Tables should be noted:

- Data Collection Parameters Not Included

  In an effort to keep the Summary Data Tables to a manageable size, the parameters used when the data was collected was not included. These parameters were archived in the individual datasets and it was felt that their inclusion in the summary would be redundant.

- Not all collected values used

In some cases where several data were collected from the same intervai, a decision was made to include only the more interesting measurements in the summary. In the smear slides datasets for example, more than 30 components were entered in the descriptions, but only the most important five were included in the Summary Data Tables.

- Depth Shifting Used

Due to the high resolution of the MST data (2.5cm) it was felt that the other datasets could be shifted to the nearest MST measurement with little loss of integrity. This approach was used on all the Summary Data Tables with a depth shifting window of 3cm.

As better methods become available in the future, they can be easily incorporated in this process.

### 4.2.4. Master Hole Columns

At the request of the Co Chief scientists, a template was made which allowed the construction of a lithologic column for the current hole in near-real time. At the end of each shift, the column was updated with the current information and posted for comments. This approach foreshadows the anticipated use of the computerized VCD program and had two major benefits:

- Most of the important controversies about the hole became apparent as it was being drilled. Consequently, the discussion and analysis of these issues began much earlier and was pretty well settled by the time the hole was completed.

- The completed Master Columns were enhanced with plots from the Summary Data Tables and formed the backbone figure for the hole summary reports.

### 4.2.5. Problems and Recommendations

#### 4.2.5.1. Shipboard System Manager Time Constraints

A conscious decision was made prior to Leg 134 that this experiment would be given a very high priority and that, if necessary, routine system manager functions would be delayed or sacrificed in order to achieve it's goals.

In practice an average of two hours per day were spent on creating, maintaining and analyzing the summary data tables. The Shipboard System Managers routinely work a 13 - 15 hour day during a cruise and the added burden of data integration cannot be readily accommodated under the current staffing levels.

If the integration of shipboard data is to become a routine function we request that DMP recommend, to JOI, the addition of a second seagoing Computer System Manager for each cruise.

4.2.5.2. Data Processing Utilities Needed

Several software tools are needed to facilitate the process of integrating the core data. These vary from simple tabulating programs like that provided by Roy Wilkens to more sophisticated filters and smoothing routines.

Producing these tools will be difficult under the current staffing levels. Therefore we request that an additional person-year be provided to the shipboard computer group for this purpose.

4.2.5.3. Shipboard Scientist Time Constraints

Use of the master data files by shipboard scientists was limited by the time they had available after performing their routine shipboard assignments. Detailed analysis of the shipboard data was generally undertaken by scientists after their regular working hours.

The suggestions forwarded by DHP with regards to a core-log correlation specialist should be very helpful in this regard.

4.2.5.4. Microcomputer Processing Power

Our efforts at data integration during leg 134 were focused on the Macintosh because it has the most complete set of data processing tools. In the future we can expect this type of work to take place equally on the Mac and PC compatible systems.

The Mac IIx used during Leg 134 should be considered a minimum configuration for this purpose. At times it took over 10 minutes for a large ASCII datafile to be uploaded into Excel. This type of data processing is repetitive in character and small processing delays quickly add up.

Due to the extremely large size of the datasets involved, our recommendation is that several specialized data processing workstations be purchased specifically for this purpose. These machines should have large screens, very fast processors, large hard disks and abundant memory.

### 4.2.6. Fixed Reference Depth

This section addresses the need for a central reference depth that spans the many different data types collected on the ship. There are three components to this problem:

- Establishing a consistent depth across the core data

- Establishing a consistent depth across the logging data

- Correlating the two into a final depth dataset for the site

To date we have only addressed the first aspect of the problem, setting a consistent depth standard for the core lab datasets.

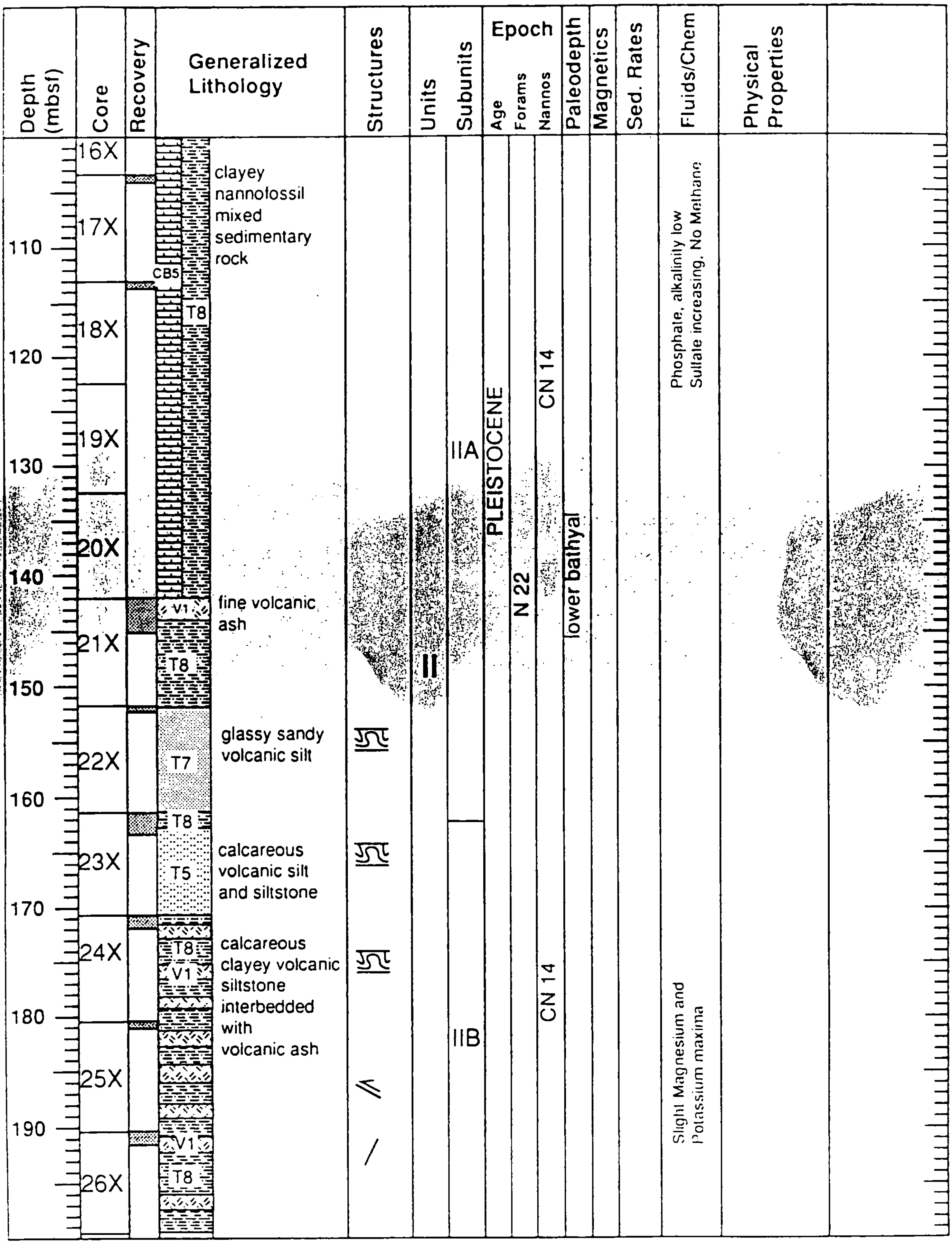
4.2.6.1. MultiSensor Track as a Reference Depth for Core Data

The Multi Sensor Track provides a convenient depth reference due to its consistent use on most cored materials, and the fine granularity of its measurements (typically, a measurement is taken every 2.5 cm).

On leg 134 we took advantage of this convenient data series for use as a reference depth for all the core data. Data from other disciplines were shifted to the nearest MST sample depth as they were merged into the Summary Data Tables described above.

This approach has the benefit of simplifying the eventual correlation of core and log data depths while providing a very useful dataset for use today. We recommend that the MST be adopted as the standard reference depth for corelab datasets.

# Master Column Leg: 134 Site: 833 Hole: A




Last Modified on: Date Time

# Data Processing Worksheet

Site: Finished:

| | *.MBSF | *.TAB | *.TXT(Local) | *.TMP(Sum. Rpts) | *Master.TXT | *Master.DESK |
|---|---|---|---|---|---|---|
| MST-Susc | Wendy | Perrick | Perrick | Perrick | Bill | Bill |
| MST-Grape | Wendy | Stefan | Stefan | Stefan | Bill | Bill |
| MST-Pwave | Wendy | Maria | Maria | Maria | Bill | Bill |
| Slides-Texture | Bill | Bill | Bill | Bill | Bill | Bill |
| Slides-Compon | Matt | Matt | Matt | Matt | Bill | Bill |
| Desc. Velocity | Maria | Maria | Maria | Maria | Bill | Bill |
| Vane-Shear Str. | Maria | Maria | Maria | Maria | Bill | Bill |
| Index Props | Maria | Maria | Maria | Maria | Bill | Bill |
| Thermcon | Mike | Mike | Mike | Mike | Bill | Bill |
| Organic Chem | Mark | Mark | Mark | Mark | Bill | Bill |
| Inorg. Chem | Mark | Mark | Mark | Mark | Bill | Bill |
| Logging | Mike | Mike | Mike | Mike | Bill | Bill |
| | | | | | | |
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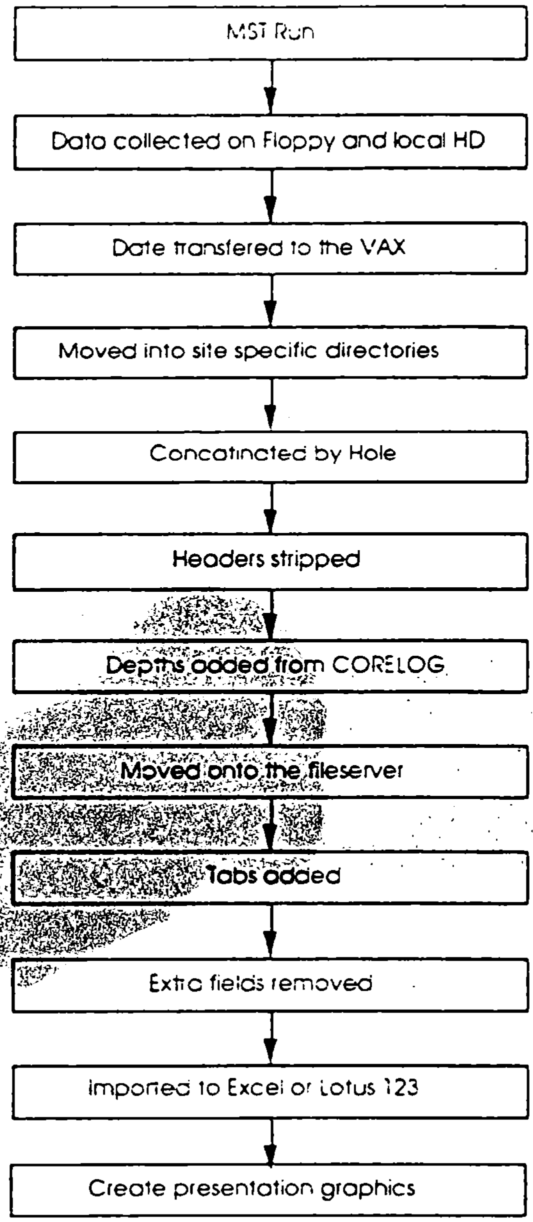
## Data File Structures

| | |
|---|---|
| *.MBSF | ODP Standard format with sub-bottom depths added. Spaces delimit columns. |
| *.TAB | *.MBSF file with space delimiters changed to TAB chars using Evolutions or TAB 1.3 |
| *.TMP | *.TAB file with extraneous columns removed, only MBSF and DATA columns remain. *.TMP begins with a blank line and has text column headers in the second line |
| *Master.TXT | Tabbed ASCII file combining multiple datasets for general distribution |
| *Master.DESK | DataDesk Professional data file combining multiple datasets for general distribution |

- Overview of data processing on the Resolution
    - We've slowly but steadily inched forward in the last six years
        - The Hardware has improved
        - The Software has improved
        - Networking has become feasible
    - A vision for the near future
        - Ship-wide integrated data system
            - DataDesk visual factor analysis demo
        - Distributed image processing
        - Natural Gamma for "true" sub-bottom depths
        - Scientists will have more control over the publications
- Where we're at now
    - The Mac's are ready, the PC's are almost there
    - The VAX is stable for the near future
    - Distributed print services are on the horizon
    - The network is ready
    - The Integrated Data system needs some tools built
    - The users aren't using what is available effectively
    - The System Manager's are barely keeping up
        - Started with two VAX systems now we have five
        - Started with 15 applications, now over 50
        - Started with 37 Pro350's, now over 70 Pro's, PC's and Macs
        - Started with simple serial communications, now InterNetwork

## How GRAPE data is processed



## Adding another dataset

Process new data to Depths stage
↓
Moved onto the fileserver
↓
Tabs added
↓
Extra fields removed
↓
Merged with "Base" dataset
↓
Imported to Excel or Lotus 123
↓
Create presentation graphics

## Establishing real-world sub-bottom depths

Collect and process corelab data
↓
Collect and process downhole logging data
↓
Correlate the two datasets
↓
Revise the Integrated Dataset depths
↓
Revise the CORELOG
↓
Advertise the changes

- A demonstration Exploratory Data Analysis (EDA)
- How we get there from here

  The items listed below are things I feel are necessary to implement the integrated data system described above in a reasonable time frame.

  - **We need about one man-year of programming effort**

    This effort will create the small to medium sized tools needed to make the system run smoothly. An example of work to be done would be a complete and polished version of the Merge and Tabulate utilities used above. These tools would only have to be created once since the bulk of the work is accomplished using commercial applications.

  - **We need to sail two System Managers on every leg**

    Sailing two System Managers would provide complete support for the integrated data system.

    - Current System Manager functions
      - VAX System Management (four systems)
      - VAX user support
      - Macintosh and PC system management
      - Macintosh and PC user support
      - Network administrator
      - Software maintenance (eleven systems)
      - Lamont VAX system management
      - Hardware troubleshooting and maintenance for all systems
    - Proposed additional responsibilities
      - Round the clock coverage
      - Integrated Data System data entry
      - Training material development

  - We need to educate the Scientific Community about this resource
    - Precruise workshops

- Published technical notes
- Hands on experience on ship and at ODP Headquarters
- Formal classes on the ship at the beginning of each cruise

ANNEXURE III

# FY1992 DOWNHOLE MEASUREMENTS PROSPECTUS
## Version 3 of CEPAC Logging Prospectus
1/14/91

**Table of Contents**



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## Introduction

This CEPAC downhole measurements prospectus has several purposes:

1) facilitate an early integration of logging into CEPAC program plans;

2) provide information to JOIDES panels (and ultimately cochiefs) on the scientific aims of logging for individual programs, including the chances of successful achievement of the aims;

3) increase the opportunity for all JOIDES panels (not just DMP and PCOM) to contribute to the design of appropriate downhole measurements programs;

4) assist in an early identification of technical needs and their priorities; and

5) evaluate the impact of drilling technology (particularly diamond coring system) on the scientific accomplishments of downhole measurements.

The document is expected to evolve. Version 1 (4/29/89) included all potential CEPAC programs but represented only the perspective of one person: Chief Scientist of the ODP Wireline Logging subcontractor. DMP used Version 1 as a strawman in its 5/89 meeting, at which initial DMP recommendations for FY90 and FY91 CEPAC programs were established. Version 2 (11/10/89) of this prospectus was revised to include only the first year of CEPAC and to reflect DMP recommendations, DMP evaluations of the scientific contributions of recommended tools, and logging times. Version 2 was distributed to the Planning Committee and panel chairmen at the 11/89 PCOM meeting. **This third version covers only FY92 programs, of which many but not all have been considered previously by DMP.** Further evolution of the prospectus will certainly result from panel feedback and from the transformation of programs into legs.

Most of the scientific objectives listed in this prospectus are based on the specific objectives mentioned for each program in the CEPAC third prospectus. However, broader objectives should not be neglected. DMP has emphasized the roles of cores and standard logs as an archival heritage for future investigations, leading to scientific accomplishments beyond those of the ODP volumes. Further, some panel objectives such as stress can be better addressed by making measurements at "targets of opportunity" than by drilling many sites specifically for stress measurements.

Projected logging accomplishments are dependent on the tools assumed to be available. We assume that all of the tools currently used in ODP will be available for FY1992:

1 ) "Standard logs" (two tool strings): waveform sonic, spectral gamma ray, resistivity, density, neutron porosity, caliper and temperature (low T) and spectral gamma ray, aluminum clay tool, gamma spectrometry, and temperature.
2 ) Formation MicroScanner and general purpose inclinometer (hole deviation, tool acceleration, magnetometer), listed separately from the standard logs below but recently classified as a standard log by PCOM;
3 ) Dual laterolog;
4 ) Vertical seismic profile tool (1-component; individual investigators <u>may</u> bring a 3-component tool);
5 ) Digital borehole televiewer;
6 ) Multichannel sonic.
7 ) Magnetometer/susceptometer;
8 ) Barnes water sampler/temperature/pressure;

Four additional tools have had little or no prior ODP use and may not be fully operational for FY92:

1 ) Wireline packer;
2) Pressure core barrel;
2 ) Geoprops probe; and
3 ) Lateral stress tool.

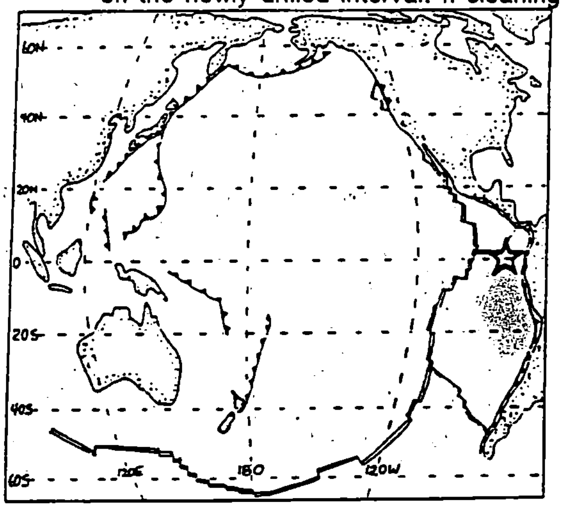
We include several other tools in leg objectives and logging tool objectives sections, accompanied by the caveat that they are unlikely to be available.

Several CEPAC programs anticipate hot holes. We generally assume that the holes can be cooled enough by circulating to permit running the tools listed above; exceptions are flagged in the text. The East Pacific Rise program is likely to use a diamond coring system for improved penetration in fractured basalt. A 4" DCS hole would exclude all of the tools above. Instead, we assume that the following slimhole tools will be available: temperature, fluid sampler, sonic (no waveforms), gamma ray, density, neutron, and resistivity. This assumption is probably too optimistic; current dewaring plans include resistivity, sonic, and gamma ray, at most. Because of the very different logging accomplishments for 4" and for larger holes, we list separately the logging tool objectives for these two hole environments.

## Penetration of Layer 3 at 504B

Thanks to the drilling and logging efforts of four DSDP legs and one ODP leg, Hole 504B is the deepest and best-studied penetration into oceanic crust. The 1288 m of penetrated basement provide an unmatched ground truth for seismic models of the structure and evolution of the oceanic crust. The hole now bottoms in sheeted dikes of Layer 2C, and a Leg 111 VSP suggests that the gabbros of Layer 3 may only be 100-450 m deeper. This program seeks to deepen 504B into the gabbros and to study the physical, hydrologic, seismic, and magnetic nature of Layer 3 and the Layer 2C/3 transition.

Leg 111 downhole measurements at 504B were cited by LITHP as one of the most important ODP accomplishments to date. Leg 137 will log temperature, sample fluids, and test flowmeter permeability logging, then attempt to remove junk from the bottom of the hole. Assuming that hole cleaning is successful, Leg 140 will deepen and log the hole. Deepening to reach gabbros (perhaps 100-450 m deeper based on VSP reflectors) is hoped for. Most downhole measurements would focus on the newly drilled interval. If cleaning is unsuccessful, Leg 140 will drill Hess Deep instead.



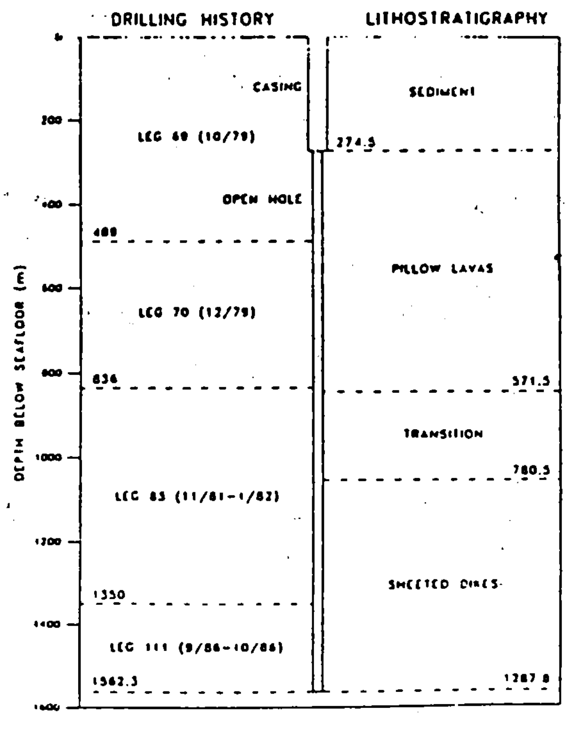




TABLE 1. Logs and experiments run in Hole 504B. In many cases the logging tools used { ODP are superior to those used during DSDP. so the logs and experiments are grouped into run during DSDP Legs 69. 70. 83. and 92. and those run during ODP Leg 111.

| Log/Experiment | Interval logged (mbsf) |
|---|---|
| **A. DSDP - Legs 69, 70, 83, and 92** | |
| Caliper log | 277-1287.5 |
| Neutron log | 277-1287.5 |
| Density log | 277-1287.5 |
| Sonic logs | |
| P. S. full waveform | 277-1287.5 |
| Multi-channel sonic | 277-426 |
| Borehole televiewer | 277-1287.5 |
| Oblique seismic experiment | |
| geophone depths | 316.5. 546.5. 726.5. 941.5 |
| Electrical resistivity | |
| SFL | 277-1287.5 |
| Large-scale experiment | |
| 45. 91. 182 m array | 277-836 |
| 10. 20. 40. 80 m array | 277-1287.5 |
| Temperature (11 separate times) | 0-1287.5 |
| Borehole fluid samples | numerous. with varying degrees of contamination |
| Packer - permeability intervals | 316.5–489. 473.5-489. 536.5-1287.5 |
| Magnetometer (Russian) | 277-489 |
| **B. ODP - Leg 111** | |
| Temperature log (French) | 0-1250 |
| Borehole water samples | |
| Schlumberger RFT | 466. 766. 1236 |
| Kuster (9 of 10 failed) | 631 |
| Neutron activation (ACT/GST) | 277-1535 |
| Lithodensity log | 277-1535 |
| Multi-channel sonic | 277-1535 |
| VSP (geophone clamped every 10 m) | 164-1535 |
| Borehole televiewer (USGS) | 1176-1531 |
| Dual Laterolog resistivity | 277-1535 |
| Magnetometer (Schlumberger) | 277-1535 |
| Packer - permeability intervals | 936-1406.8. 1236-1547.5 |

| Site I.D. | Water Depth | Penetration Sed. | Bsmt. | |
|---|---|---|---|---|
| 504-B | 3460 | 275 | 1400-1750 | 1288 m basement already cored and logged |

**PREVIOUS PLANS FOR LOGGING:**

On 5/89, DMP developed the plan listed below. Since then, the only changes have been in the subjects raised by the final three paragraphs: flowmeter permeability is scheduled for Leg 137 and hole sealing technology is under development.

Lower Crust - Penetration of Layer 3 at 504B

Scientific Objectives

Physical, chemical, seismic, magnetic and hydrological nature of Oceanic Layer 3.

Dyke to gabbro transition

Relevant DMP Thematic Thrusts

Crustal composition and structure
Hydrogeology

Logging Programme (assuming 5" hole or greater)

Entire hole (pre-existing and new sections):

Geochemical string
FMS
Wireline packer
Temperature tool
Magnetometer/susceptibility (high sensitivity tool)

New hole only:

Seismic stratigraphic string
Packer
BHTV (200 m of overlap into pre-existing hole)
Dual laterolog

Good temperature logs and water samples are needed before the junk is cleared from 504B.

Estimated bottom hole temperature in pre-existing hole is 160°C: at base of new hole (2000 m) it will be about 190°C. This raises a question concerning the temperature range of the above tools.

This logging programme assumes at least a 5-inch hole. It would be regrettable if 504B had to be re-accessed with a primitive logging suite as would be necessitated if the DCS were to be used for hole deepening.

Permeability can be evaluated through flowmeter injection. A spinner flowmeter would have to be included in the logging programme. Before making a final decision, Panel asked if a typical data scenario could be prepared with indications of ranges of permeability and corresponding accuracies and precisions.

[ACTION : MORIN]

The question was raised of sealing the hole after drilling to minimize downflow and thereby to recover subsequently better fluids and temperature. For the same reason it is desirable to isolate the bottom of the hole. The feasibility of this proposal should be established.

[ACTION : FISHER]

DMP Consensus

Long-term sealing should be effected after further drilling at 504B with subsequent in-hole experiments directed at temperature and fluid flow.

**LEG OBJECTIVES:**

1. Geophysical properties of Layer 2C/3 transition and upper Layer 3. The prime objective of this leg is "to provide ground truth for seismic models of the structure and evolution of the oceanic crust". Layer 3 is assumed to be gabbro but is defined and regionally mapped on the basis of velocity. Velocity, density, and porosity of both the Layer 2C/3 transition and of Layer 3 need to be measured and compared to the simple seismic models. Standard logs will suffice in these massive units; multichannel sonic or a VSP does not appear to be necessary. Chance of success: excellent.

2. Geologic controls on the geophysical properties of Layer 2C/3 transition and upper Layer 3. This objective requires comparison of the continuous geophysical logs with similarly continuous

"geologic" records: classification of dikes, sills (if any), intrusive bodies, fossil magma chambers, etc; petrologic character of the units; fracture pattern; and hydrothermal alteration.

a) Discrimination of dikes, sills, intrusive bodies, fossil magma chambers, etc. Standard logs can discriminate unit boundaries and identify some types of units on the basis of geochemical signature. However, FMS and/or televiewer will be needed to classify the remainder of units. For example, the strike and dip of dikes or sills can be determined by either the FMS or BHTV; ideally, both would be used because their measurements (resistivity and impedance) are sufficiently different that each may pick up some features missed by the other.

b. Geochemistry and modal mineralogy of units. Major element geochemistry from standard logs can provide a quantitative picture of fractionation, alteration, and -if present- changing magma sources. Because the geochemical logs sample both fresh and altered rock, alteration may partially prevent log detection of some primary geochemical differences. However, the advantage of this representative and quantitative sampling of alteration is that one can potentially estimate the total geochemical fluxes into and out of basement, caused by hydrothermal alteration. Modal mineralogy can be calculated from the geochemical logs.

Some petrologic sources of geochemical variations, such as crystal settling, will also have important effects on other standard logs (e.g. velocity). Even though geochemical logs were obtained on Leg 111, logging of the entire hole is desirable on this leg, for two reasons. First, the new boron-sleeved gamma spectroscopy tool is more accurate than the tool used on Legs 101-125. Second, Hole 504B is the only hole for which the old and new tools will definitely have been used, enabling a comparison and possibly correction of old data.

c) Fracturing and faulting in Layers 2 and 3. Standard logs provide only a qualitative record of fracture intensity. Dual laterolog sees a deeper, more representative fracture porosity and provides a qualitative indicator of the relative proportions of subhorizontal and subvertical fractures. Borehole televiewer and FMS image individual fractures (their azimuth, aperture, and whether they are filled or open). Hole 504B has already intersected one possible fault and deeper penetration may encounter additional faults. Faults should be a particular focus of high-resolution imaging and packer work, because of their tectonic implication and disproportionate influence on hydrothermal circulation. Televiewer imaging of the possible fault has already been obtained; FMS logging is fast enough to log the old penetration including the fault, at only a minor increment of time beyond that needed to log the new penetration.

3. Hydrothermal processes in the oceanic crust. The deepened Hole 504B will warrant the same multifaceted approach to hydrothermal circulation utilized on Leg 111: fracturing and faulting (already discussed); permeability; fluid flow; fluid sampling; and hydrothermal alteration.

a) Permeability. In low-permeability formations such as those anticipated, permeability can be measured with the straddle packer, single drillstem packer, or possibly injection flowmeter. Packer work will focus on the new hole but may also target shallower problem areas.

For example, straddle packing across the hypothesized fault would indicate how much, if any, of the deep permeability is localized in this zone.

b) Active fluid flow. Temperature logs can be obtained on most tool strings, but the expected temperatures of up to 200°C indicate that dedicated runs of a high-temperature tool are needed. Temperature logs indicate the locations of zones of present fluid flow and provide semiquantitative measures of flow rate. When combined with a thermal conductivity log from log-based mineralogy and porosity, the ability of temperature logs to detect subtle fluid flow is substantially improved. If several temperature logs are available, an equilibrium thermal gradient can be calculated, yielding heat flow and an indication of broad-scale conductive vs. convective heat transport. However, drilling conditions are likely to require slow long-term cooling of the hole to prevent formation damage. It is therefore uncertain whether even repeated temperature runs will permit accurate extrapolation of equilibrium temperatures. Pore pressure can be measured with the wireline packer. Flowmeter experiments such as those on Leg 111 may be useful, more from the standpoint of between-leg changes in flow rates than from the expectation that the hole deepening contributes to observed flow.

c) Fluid sampling. The lack of reliable fluid sampling is possibly the major shortcoming of previous work at 504B. Many attempts failed to obtain any fluids, and virtually all samples were of fluids in the drillhole rather than of uncontaminated and well-located formation fluid. Interstitial water sampling of course was not possible. An intensive program of wireline-packer fluid sampling throughout Hole 504B appears to be needed.

d) Hydrothermal alteration. Abundance of alteration minerals can be determined by inversion of standard logs. Core measurements of cation exchange capacity, coupled with a resistivity log and log estimates of bound vs. free water, appear to be more reliable than straight geochemical log inversion. Log-based estimation of alteration mineral abundance is more representative than core studies of alteration and is therefore essential to understanding the permeability distribution.

4. Magnetic properties of oceanic crust. Debates continue concerning the relative contributions of different crustal layers to marine magnetic anomalies, primarily because samples from ophiolites and dredges are not representative. Hole 504B is the best place to test crustal magnetization models because of its very deep penetration. The quality of previous magnetometer logs at 504B is far below present capabilities. A magnetometer/susceptometer is needed, with a built-in gyroscope for determination of declination. Because the interval 900-1500 mbsf is weakly magnetic, a higher sensitivity than the Leg 111 Schlumberger magnetometer is needed to test the Leg 111 interpretation of tilting associated with the penetrated fault.

5. Comparison of Hole 504B and Site 735. Assuming that Hole 504B reaches gabbros, it will be important to compare and contrast in situ measurements of gabbros at the two sites. Unlike the normal crustal section at 504B, Site 735 has apparently been tectonically slivered, so that

gabbros outcrop, an unknown portion of upper Layer 3 is missing, and the degree of fracturing and hydrothermal alteration is atypical. The types of downhole measurements already obtained at 504B and 735 are similar to those anticipated for 504B deepening, so this comparison will be a natural outgrowth of the new 504B interpretation.

**LOGGING TOOL OBJECTIVES:**

1. Standard logs: geophysical properties ($V_p$, $V_s$, density) of Layer 2C/3 transition and upper Layer 3; controls on geophysical properties (composition, fracture porosity, alteration); delineation of volcanic units (sills, dikes, etc.); geochemistry of units, with at least partial separation of fractionation, alteration, and magma source effects; geochemical fluxes into and out of oceanic crust; modal mineralogy; qualitative intensity of fracturing; thermal conductivity; abundance of alteration minerals; comparison to geophysical and geochemical properties of Site 735.

2. FMS and/or televiewer: refined delineation of volcanic units; quantitative fracture density, azimuth and aperture, and whether fractures are open or filled with secondary minerals; strike and dip of dikes; fault imaging and detection of differential tilting across faults; style and geometry of large-scale porosity. Because the televiewer provides a 360$^{o}$ image, it will be generally superior to the FMS for these objectives. However, FMS will probably be much more sensitive to variations in alteration and may detect some features missed by televiewer. High priority for both; televiewer in new hole, FMS in entire hole.

3. Wireline packer or other fluid sampler: fluid samples for hydrothermal alteration studies. High priority throughout the hole; wireline packer provides the only in situ fluid-sampling capability in this environment. Technical problems are anticipated in the deeper portion of the hole: long pumping times when permeability is low; no fluid samples obtained when permeability is very low; and possibly temperatures too high for the packer and electronics. DMP is expected to decide in 2/91 whether or not to recommend further development of the wireline packer.

4. Packer: permeability (>10 m scale), for hydrothermal processes objective. High priority, for a few measurements in both old and new portions of hole.

5. Temperature tool (high-temperature): identification of zones with active fluid flow; heat flow. Temperatures will be too high for the L-DGO combinable temperature tool. At least three logging runs of this tool may be needed. A major circulation program will probably be run to cool the hole for drilling and logging, possibly making it impossible to determine equilibrium thermal gradient; thus only the zones with very active fluid flow will be identifiable. High priority.

6. Magnetometer/susceptometer: magnetic properties of oceanic crust (especially Layer 3), including effect of alteration; flow delineation. High priority?

7. Dual laterolog: resistivity of massive units, for fracture porosity of the lowest-porosity zones; relative proportions of subhorizontal to subvertical fractures. High priority; conventional resistivity logs will probably not be reliable because of anticipated very high resistivities.

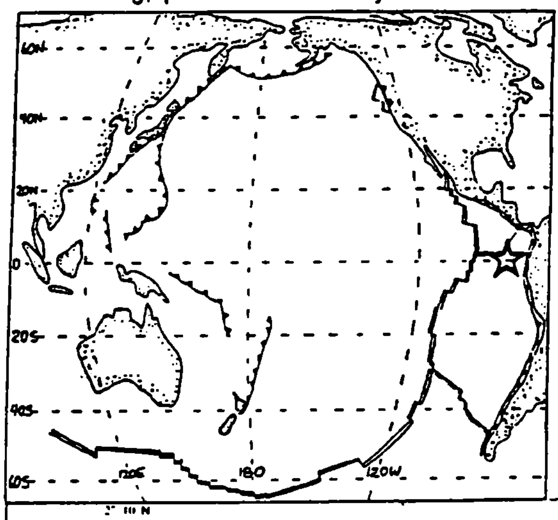
**NEED FOR NEW LOGGING TECHNOLOGIES :**

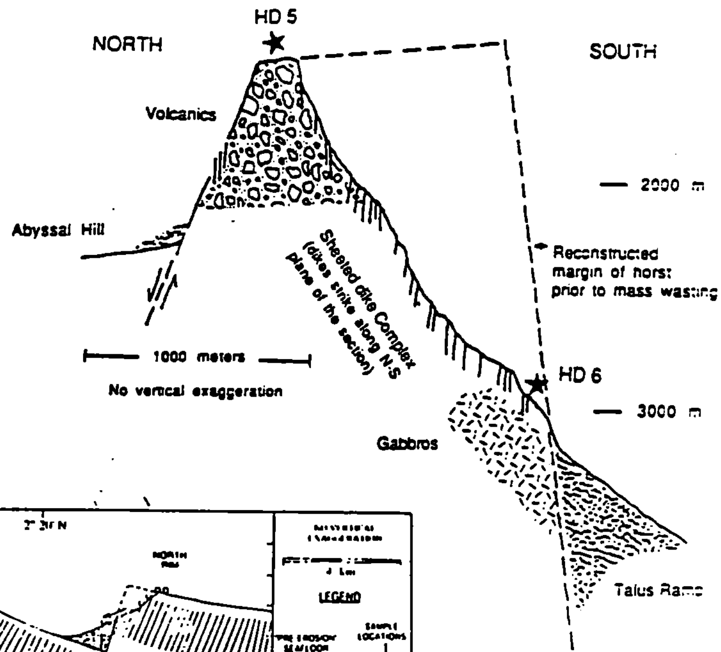
Minor hole cooling for standard tools. Temperature tool reliable to 200°C.

## Hess Deep

This program seeks to study the deepest portion of oceanic crust and the contact between lower crust and Moho, by skipping the upper crust. In Hess Deep, pervasive normal faulting exposes virtually all portions of the oceanic crust; pogo drilling can sample any desired portion of the crust with a relatively shallow-penetration hole. The first hole would begin at a crustal layer deeper than the bottom of 504B and possibly penetrate Moho. Objectives are to study the physical, hydrologic, seismic, and magnetic nature of Layer 3 and the Moho transition. Standard rotary drilling will be used.

Leg 111 downhole measurements at 504B were cited by LITHP as one of the most important ODP accomplishments to date. Similar success can be anticipated for the deeper crustal section at Hess Deep. A multileg program is anticipated, but only one leg is scheduled: Leg 140 if 504B cleanout is unsuccessful, otherwise Leg 147. Either HD-1 or HD-2 would be drilled on this first leg; penetration is very uncertain.





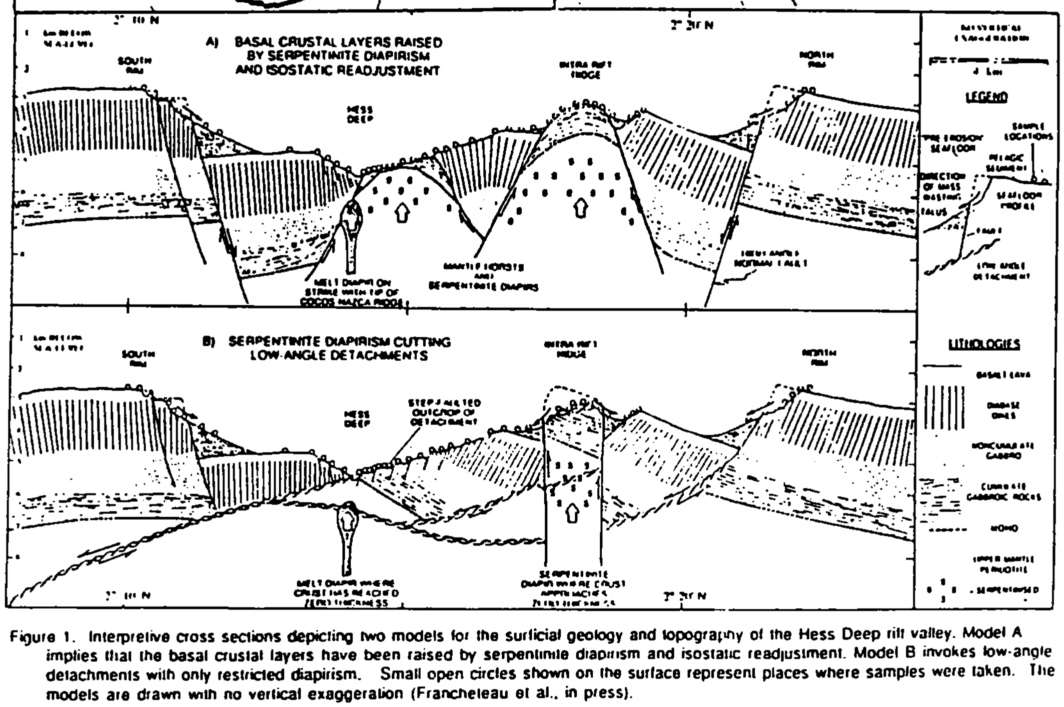




Figure 1. Interpretive cross sections depicting two models for the surficial geology and topography of the Hess Deep rift valley. Model A implies that the basal crustal layers have been raised by serpentinite diapirism and isostatic readjustment. Model B invokes low-angle detachments with only restricted diapirism. Small open circles shown on the surface represent places where samples were taken. The models are drawn with no vertical exaggeration (Francheteau et al., in press).

| Site | Water | Penetration | |
|---|---|---|---|
| I.D. | Depth | Sed. | Bsmt. |
| HD-1 | 4500 | -- | 1000 R |
| HD-2 | 5000 | -- | 1000 R |

**PREVIOUS PLANS FOR LOGGING:**

Never considered in detail by DMP, but 10/90 DMP meeting said probably similar to 504B.

**LEG OBJECTIVES:**

1. Geophysical properties of Layer 3 and Moho. Seismic models of variations in thickness of the oceanic crust need to be tested, through in situ measurements of velocity, density, and porosity. Standard logs will suffice in these massive units; multichannel sonic or a VSP does not appear to be necessary. Chance of success: excellent.

2. Geologic controls on the geophysical properties of lower crust and Moho transition. This objective requires comparison of the continuous geophysical logs with similarly continuous "geologic" records: classification of dikes (if any), sills (if any), intrusive bodies, cumulates, fossil magma chambers, etc; petrologic character of the units; fracture pattern; and hydrothermal alteration.

a) Discrimination of dikes, sills, intrusive bodies, cumulates, fossil magma chambers, etc. Standard logs can discriminate unit boundaries and identify some types of units on the basis of geochemical signature. However, FMS and/or televiewer will be needed to classify the remainder of units. For example, the strike and dip of dikes or sills can be determined by either the FMS or BHTV; ideally, both would be used because their measurements (resistivity and impedance) are sufficiently different that each may pick up some features missed by the other.

b. Geochemistry and modal mineralogy of units. Major element geochemistry from standard logs can provide a quantitative picture of fractionation, alteration, and -if present- changing magma sources. Because the geochemical logs sample both fresh and altered rock, alteration may partially prevent log detection of some primary geochemical differences. Modal mineralogy can be calculated from the geochemical logs. Some petrologic sources of geochemical variations, such as crystal settling, will also have important effects on other standard logs (e.g. velocity).

c) Fracturing and faulting. Standard logs provide only a qualitative record of fracture intensity. Dual laterolog sees a deeper, more representative fracture porosity and provides a qualitative indicator of the relative proportions of subhorizontal and subvertical fractures. Borehole televiewer and FMS image individual fractures (their azimuth, aperture, and whether they are filled or open).

3. Hydrothermal processes in the deep oceanic crust. This objective is a very high priority

at 504B and EPR, but it may not be important at Hess Deep, both because of limited hydrothermal circulation *in situ* in lower crust and because the sections exposed here have atypical hydrothermal circulation. If this objective is worth addressing, one would use the same multifaceted approach utilized on Leg 111: fracturing and faulting (already discussed); permeability; fluid flow; fluid sampling; and hydrothermal alteration.

4. Magnetic properties of lower oceanic crust. Debates continue concerning the relative contributions of different crustal layers to marine magnetic anomalies, primarily because samples from ophiolites and dredges are not representative. Based on Leg 118 and dredges, gabbros can be highly magnetic; additional representative sections are needed.

**LOGGING TOOL OBJECTIVES:**

1. Standard logs: geophysical properties ($V_p$, $V_s$, density) of Layer 3 and Moho; controls on geophysical properties (composition, fracture porosity, alteration); delineation of units (sills, dikes, etc.); geochemistry of units, with at least partial separation of fractionation, alteration, and magma source effects; modal mineralogy; qualitative intensity of fracturing; thermal conductivity; abundance of alteration minerals.

2. FMS and/or televiewer: refined delineation of volcanic units; quantitative fracture density, azimuth and aperture, and whether fractures are open or filled with secondary minerals; strike and dip of dikes (if any); fault imaging and detection of differential tilting across faults. Because the televiewer provides a 360° image, it will be generally superior to the FMS for these objectives. However, FMS will probably be much more sensitive to variations in alteration and may detect some features missed by televiewer. Stress measurement may not be very useful here, because stress direction may be controlled by local topography.

3. Wireline packer: fluid samples for hydrothermal alteration studies. This tool provides the only in situ fluid-sampling capability in this environment. Technical problems are anticipated in parts of the hole: long pumping times when permeability is low; no fluid samples obtained when permeability is very low; and possibly temperatures too high for the packer and electronics. Low priority?

4. Packer: permeability (>10 m scale), for hydrothermal processes objective. Moderate priority?

5. Temperature tool (high-temperature): identification of zones with active fluid flow; heat flow. Temperatures may be too high for the L-DGO combinable temperature tool. At least three

logging runs of this tool may be needed. Drilling-related circulation probably will cool the hole enough for logging, possibly making it difficult to determine equilibrium thermal gradient. High priority?

6. Magnetometer/susceptometer: magnetic properties of lower oceanic crust. High priority?

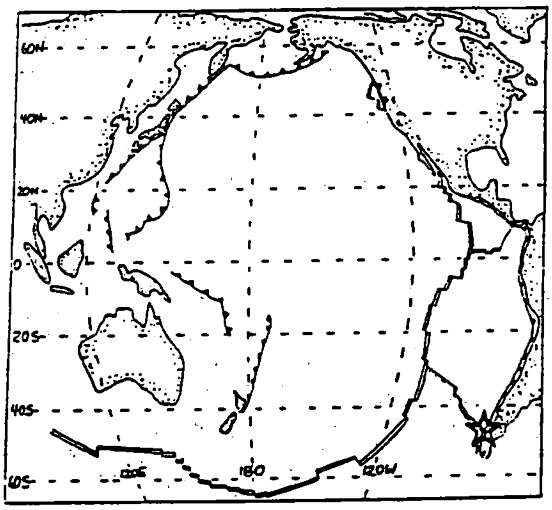
7. Dual laterolog: resistivity of massive units, for fracture porosity of the lowest-porosity zones; relative proportions of subhorizontal to subvertical fractures. High priority; conventional resistivity logs will probably not be reliable because of anticipated very high resistivities.

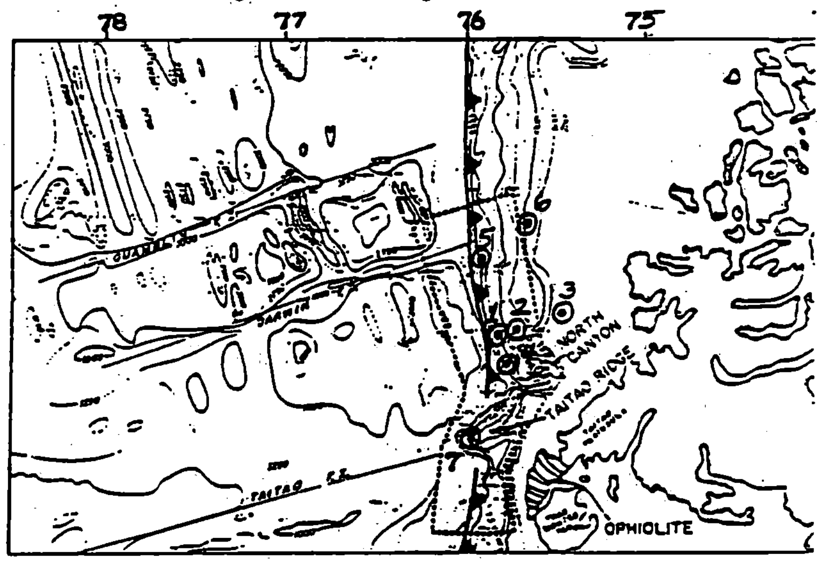
**NEED FOR NEW LOGGING TECHNOLOGIES :**

Minor hole cooling for standard tools. Temperature tool reliable to 200°C.

## Chile Triple Junction

Many of the subduction zones of the Pacific have experienced ridge-crest subduction during the Tertiary. By studying a currently active example of ridge subduction, we can more fully understand the incomplete clues in the rock record of ancient ridge subductions. With two suites of forearc drillsites (one perpendicular to the point of ridge-trench collision and one sampling forearc before, during, and after collision), one can determine the effect of ridge subduction on forearc vertical motions, hydrothermal circulation, deformation, and erosion. Sites listed below are for a two-leg program, but only one leg is scheduled. Asterisks mark a guess concerning which sites will be drilled during this one leg.




| Site I.D. | Water Depth | Penetration Sed. | Bsmt. | Log Hours | |
|---|---|---|---|---|---|
| *TJ-1 | 2320 | 800 | 25 | 73 | base of trench slope, during ridge subduction |
| *TJ-2 | 1700 | 800 | -- | 43 | mid-slope |
| *TJ-3 | 1020 | 800 | -- | 41 | upper slope |
| *TJ-4 | 2905 | 300 | 100 | 55 | base of trench slope, just after ridge subduction |
| *TJ-5 | 2760 | 800 | 25 | 74 | base of trench slope, just before ridge subduction |
| TJ-7 | 1280 | 500 | 50 | 36 | Taitao Ridge |
| *TJ-8 | 2500 | 700 | 50 | 36 | base of trench slope, during ridge subduction |
| TJ-9 | 1900 | 700 | -- | 34 | upper slope, long after ridge subduction |
| TJ-10 | 2025 | 600 | -- | 33 | mid slope, long after ridge subduction |
| TJ-11 | 800 | 900 | 10 | 26 | upper slope, long after ridge subduction |
| TJ-12 | 1800 | 500 | 25 | 31 | upper slope, long after ridge subduction |
| TJ-13 | 2050 | 800 | -- | 36 | mid slope, long before ridge subduction |
| TJ-14 | 1125 | 700 | -- | 33 | upper slope, long before ridge subduction |
| TJ-15 | 900 | 700 | -- | 33 | upper slope, long before ridge subduction |

## PREVIOUS PLANS FOR LOGGING:

Chile Triple Junction (5/89 DMP)

Scientific Objectives

Investigate subsidence, deformation, volcanism and metamorphism within the collision zone.

Investigate the process of ophiolite emplacement at Taitao Ridge.

Investigate the process of "rebuilding" of the margin after the triple junction passes northward.

Relevant DMP Thematic Thrusts

Intraplate stress
Hydrogeology

Logging Programme

Sites TJ-1 , TJ-4 , TJ-5 ;

Standard logging suite (including FMS)
Wireline packer
Geoprops probe
WSTP

Site TJ-7 ;

Standard logging suite (including FMS)

Sites TJ-2 and TJ-3;

Standard logging suite (including FMS)

There is a possibility of high temperatures at these sites. ODP needs to think seriously about high temperature tools. If FMS cannot be run because of temperature considerations. BHTV should be run. High-temperature cable or cableheads will need to be available.

DMP Consensus

Panel noted that stress-direction measurements appear to have been overlooked in the Chile Triple Junction programme and wish to alert CEPDPG to this apparent omission.

Sites TJ-8, TJ-9, TJ-10;

These three sites have recently been proposed to study how the continental margin develops. In the absence of further information, the logging programme should be the same as that for sites TJ-1 et seq.

DMP recommendations of 5/89 were made before thematic panels asked the proponents to expand the drilling to two legs. A subsequent CEPDPG refinement utilized the two-leg scenario and DMP recommendations, including the DMP recommendation for some fluid objectives. Sites to be drilled in the current one-leg plan have not been specified in detail, but they are likely to be almost the same as in the original DMP evaluation (except TJ-8 could be substituted for TJ-5).

## LEG OBJECTIVES:

1. Effect of ridge trench collision on lithologies and depositional environments of slope sediment sequences (all sites). Lithologies from standand logs, depositional environments from FMS. Chance of success: very good. Largely achievable with core, but RCB and possible sands will limit core recovery.

2. Effect of ridge trench collision on vertical motion history of trench slope (TJ-1, TJ-2, TJ-3). Paleodepth indicators are large forams (cores) and sedimentary facies (cores, FMS, standard logs). Chance of success: fair, because forams have poor depth resolution in moderately deep water. Porosity and density from standard logs are useful, but not essential, for backstripping/decompaction.

3. Effects of hydrothermal circulation on lower trench slope, before, during and after ridge subduction (TJ-1, TJ-4, TJ-5).

a) present fluid flow can be measured with geoprops, wireline packer, and temperature tool. No reentry cone for packer; drilling packer possible. Chance of success: uncertain. Only

T-tool has been tested in ODP. Measure temperature with Uyeda probe and T-tool and estimate thermal conductivity from log-based mineralogy. Possible high downhole temperature at TJ-4 may prevent use of geoprops, wireline packer, and T-tool.

b) fluid samples from Barnes WSTP, pressure core sampler, and wireline packer. Fluid chemistry very important. Relative chlorinity log from standard logs.

c) porosity from standard logs, approximate fracture pattern from FMS. Chance of success: very good.

d) sediment mineralogy and geochemistry from standard logs may give clues to hydrothermal circulation history. Chance of success: fair, much less straightforward than for oceanic crustal analogues with "known" pre-hydrothermal composition.

4. Structural fabric and deformation at toe of overthrusting plate, and relation to ridge subduction (TJ-1, TJ-4, TJ-5). High-resolution structural dip, folding, tilting, and delineation of many fractures - all oriented - with FMS or televiewer. FMS probably better (though not 360° picture) because many sediments are high porosity and may have washouts. Chance of success: very good.

5. Sediment source history. Mineralogy (including clay mineralogy) from standard logs.

**LOGGING TOOL OBJECTIVES:**

1. FMS: structure and deformation of overriding plate, sedimentary facies, stress direction (not a stated leg objective). High priority at toe sites TJ-1, TJ-4, TJ-5, and TJ-8. Moderate priority at "undeformed" sites TJ-2 and TJ-3.

2. Standard logs: lithology, mineralogy, temperature, chlorinity, seismic stratigraphy (not a stated leg need). Moderate priority at all sites, all 400-825 m penetration.

3. Wireline packer: hydrothermal circulation (fluid flow, fluid properties, fluid sampling, permeability) at toe sites TJ-1, TJ-4, and TJ-5. Geoprops and WSTP would be valuable in addition, for achieving the important (but not prime) objective of studying hydrothermal circulation associated with underthusting of very hot crust.

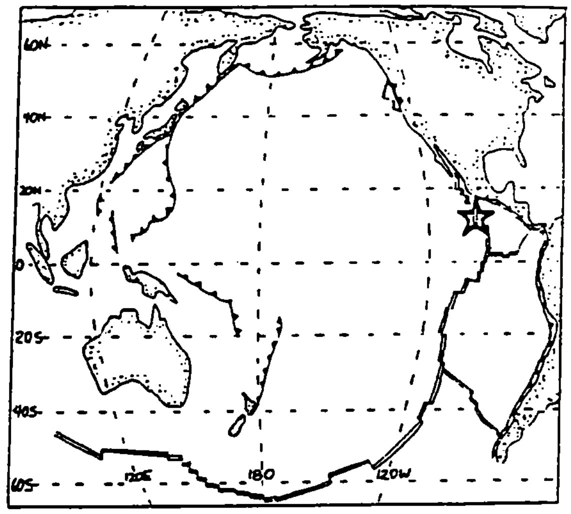
4. Pressure core sampler: gas (methane?) sampling of clathrates, fluid chemistry. Chance of success: uncertain, minimal ODP tests.

**NEED FOR NEW LOGGING TECHNOLOGIES:**

Toe sites (TJ-1, TJ-5, & TJ-4) could have dramatic temperature variations and some hot fluids. Wireline packer sampling of hot fluids desirable but not possible. Using fluid circulation to cool the hole will greatly reduce the usefulness of temperature logs. Wireline packer and geoprops have not been used in ODP yet, but ODP use long before this leg is planned.

## East Pacific Rise

With the exception of 50 m of bare-rock drilling on the Mid Atlantic Ridge (Legs 106 and 109), every DSDP and ODP basement penetration has sampled oceanic crust after much or all of its hydrothermal alteration is completed. In contrast, this program proposes to sample crust before and during the early phases of hydrothermal circulation. Bare rock drilling at and near the crest of the East Pacific Rise may reveal the physical and compositional structure of young oceanic crust, as well as the physical and chemical characteristics of earliest alteration.



The current phase of CEPAC will only begin the first site, with anticipated penetration of 100-300 mbsf. Hot (400°C), brittle rock is expected; DCS and slimhole logging will be used. Because of anticipated poor hole conditions, penetrations may be optimistic and holes may not be loggable.

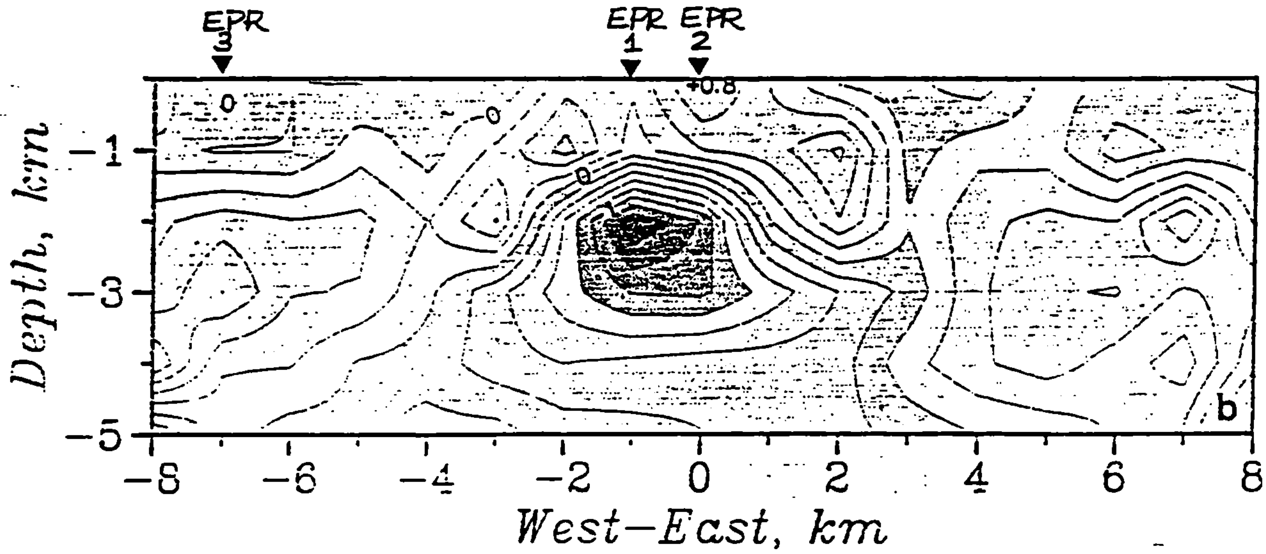



Figure: Crustal velocity anomalies, computed as local differences from an area-wide mean velocity depth structure (Toomey et al., 1990). Black negative anomaly is magma chamber.

| Site I.D. | Water Depth | Penetration Sed. | Bsmt. | | | |
|---|---|---|---|---|---|---|
| EPR-1 | -3500 | 0 | 1000-1500 | R | Legs 1 & 2? | slightly off axis |
| EPR-2 | -3500 | 0 | 500 | R | Leg 3? | ridge axis |

**PREVIOUS PLANS FOR LOGGING:**

DMP recommendations of 5/89 were:

EPR Bare Rock Drilling

Scientific Objectives

Definition of water-rock reaction zone above the axial magma chamber.

Physiochemistry of earliest phase of hydrothermal alteration.

Physical nature of geophysical horizons.

Spatial and temporal variability of magma composition.

Physical and compositional nature of zero-age crust.

Long-term experiments to determine temporal variations in the physical state of the crust and the chemistry of circulating fluids.

Relevant DMP Thematic Thrusts

Crustal structure and composition
Intraplate stress
Long-term monitoring
Hydrogeology

Logging Programme

With no temperature and diameter limitations:

Standard logging suite (including FMS)
BHTV
Wireline packer
Packer
Temperature
Magnetometer/susceptibility
VSP

In reality, temperatures of up to 400°C are expected. Unless hole cooling experiments are successful, high-temperature tools will be needed. A possibility would be to run Schlumberger hostile environment logging (HEL) tools but only to intermediate depths. Target must be to get as close to the above suite as possible taking account of the expected temperatures and with the possibility of a 4-inch hole.

At all subsequent DMP meetings, DMP considered high-T options. The 9/89 joint meeting of DMP and LITHP set high-T logging priorities as: temperature, fluid resistivity, formation resistivity, gamma ray, sonic, caliper, flow, and pressure. Based on costs and availabilities for such tools, the 10/90 DMP meeting revised high-T priorities to: 1) temperature and fluid pressure, 2) fluid sampling, and 3) formation resistivity.

In 9/90 the East Pacific Rise Detailed Planning Group report said, "If priorities must be assigned, the highest must be placed with achieving a high rate of core recovery (at least 50%). If the DCS, which will receive its next testing on the initial EPR engineering leg, does not provide adequate recovery, additional efforts should be put into developing the capability to ream the holes so that standard diameter logging tools can be used to compensate for low core recovery. . . Determining the temperature structure in the upper crust in the mid-ocean ridge environment is undoubtedly the single most important goal of downhole operations. . . The next most important single measurement would be of the fluid conductivity, which could be used as an indicator of the salinity of the fluids." The EPRDPG also suggested pressurized fluid sampling, geochemical logging, resistivity, velocity, caliper, televiewer, permeability, and instrumented hole sealing. However, they scheduled only 3.5 days total for downhole measurements and no time for reaming, and TAMU has said subsequently that actual downhole measurement time may be much smaller. Realistically, one can expect only temperature logging, fluid sampling, and hole sealing to occur on the first EPR leg, though cochiefs would want backup capability for much more extensive downhole measurements.

LEG OBJECTIVES:

1. Physical and chemical characteristics of hydrothermal alteration of newly formed crust.

a) Potential fluid conduits: large-scale porosity (e.g. pillows, talus), fine-scale porosity (e.g. vesicularity), and fracture porosity. All three types of porosity can be detailed through a combination of several logs: (1) standard sonic ($V_p$, $V_s$, attenuation), density, neutron, and resistivity yield total porosity measurement with somewhat different depths of penetration; in combination, they distinguish true porosity from apparent porosity of bound water in clays; (2) dual laterolog sees a deeper, more representative porosity and provides a qualitative indicator of the relative proportions of subhorizontal and subvertical fractures; (3) borehole televiewer and FMS image individual fractures (azimuth, aperture, and whether they are filled or open); (4) borehole televiewer and FMS image large vesicles and provide a semiquantitative measure of vesicularity; and (5) borehole televiewer and FMS provide a high-resolution picture of the style and geometry of large-scale porosity.

b) Permeability. In high-permeability formations such as those anticipated, permeability can be measured with the straddle packer, single drillstem packer, or probably by flowmeter injection.

c) Active fluid flow. Temperature logs can be obtained on most tool strings, but the anticipated high temperatures require dedicated runs of a high-temperature tool. Temperature logs indicate the locations of zones of present fluid flow and provide semiquantitative measures of flow rate. When combined with a thermal conductivity log from log-based mineralogy and porosity, the ability of temperature logs to detect subtle fluid flow is substantially improved. If several temperature logs are available, an equilibrium thermal gradient can be calculated, yielding heat flow and an indication of broad-scale conductive vs. convective heat transport. Temperature logs may also be needed during the drilling, for safety reasons.

d) Fluid sampling. Determination of the chemical composition of pore fluids is essential for an understanding of mass fluxes into and out of basalt due to hydrothermal circulation. Wireline packer is the only method for obtaining direct, uncontaminated samples of pore fluids rather than drillhole fluids. However, the high temperatures will exclude wireline packer use and require tools that sample drillhole fluids.

e) Hydrothermal alteration. Abundance of alteration minerals can be determined by inversion of standard logs. Core measurements of cation exchange capacity, coupled with a resistivity log and log estimates of bound vs. free water, appear to be more reliable than straight geochemical log inversion. Log-based estimation of alteration mineral abundance is more representative than core studies of alteration and is therefore essential to understanding the permeability distribution.

2. Geophysical properties of very young oceanic crust, and the relationship of hydrothermal alteration to these properties. Between-site comparison of geophysical logs, as well as intrasite comparison of geophysical logs to alteration indices, can reveal the effect of hydrothermal

alteration on geophysical properties.

a) In situ velocities are essential as ground-truth for regional mapping of seismic horizons; core measurements are non-representative. Velocity ($V_p$, $V_s$, attenuation), density, and porosity can be measured with standard logs, but multichannel sonic would be superior to standard sonic in the high-porosity portions of these holes. A VSP would be valuable at each site, because the shallow sampling of the sonic tools may not be representative of average velocity at seismic frequencies in high-porosity, rubbly basalt. At least one VSP is essential at EPR-1, for imaging of the magma chamber ahead of the bit, both for safety and scientific reasons.

b) Magnetic properties can be measured with a magnetometer/susceptometer. In situ magnetic measurements in the hot portions of the hole will see a thermoviscous magnetization free of the obscuring effects of cooling and pipe magnetization on cores; however, the hole cooling during drilling and possibly logging may affect this magnetization. Intersite comparison of magnetization directions will indicate the extent to which tectonic tilting is responsible for the anomalous magnetization directions often seen in older crust.

3. Physical and compositional structure of young oceanic crust.

a) Flow delineation. Identification of individual flow units can be accomplished with a variety of standard logs, both geophysical and geochemical. A magnetometer log is also useful; the magnetometer on the standard string will suffice. FMS and especially borehole televiewer refine this unit delineation.

b) Volcanology: discrimination of pillows, sheet flows, sills, talus, and possible dikes. This discrimination is largely achievable with standard logs, but the FMS and especially the borehole televiewer provide a final confirmation.

c) Geochemistry and modal mineralogy of flow units. Major element geochemistry from standard logs can provide a quantitative picture of fractionation, alteration, and -if present- changing magma sources. Because the geochemical logs sample both fresh and altered rock, alteration may partially prevent log detection of some primary geochemical differences. However, the advantage of this representative and quantitative sampling of alteration is that one can potentially estimate the total geochemical fluxes into and out of basement, caused by hydrothermal alteration. A prime target of the geochemical logging is the reaction zone overlying the axial magma chamber at EPR-1. Modal mineralogy can be calculated from the geochemical logs.

4. Long-term experiments, to detect changes in physical state of crust and chemistry of circulating fluids. Holes may be sealed for long-term monitoring of fluid pressures, temperatures, flow rates, and chemistry.

**LOGGING TOOL OBJECTIVES (Assuming successful reaming):**

1. Temperature tool (high-temperature): identification of zones with active fluid flow; heat

flow. Temperatures will be too high for the L-DGO combinable temperature tool. At least three logging runs of this tool may be needed. A major circulation program to cool the hole for drilling and logging might make it impossible to determine equilibrium thermal gradient; thus only the zones with very active fluid flow will be identifiable. High priority.

2. Fluid sampler: fluid samples for hydrothermal alteration studies. High priority throughout the hole. The high temperatures exclude wireline packer use; possibly a Sandia or Los Alamos tool will be used. Technical problems such as slight sample contamination are anticipated.

3. Standard logs: large-scale porosity for comparison to permeability; thermal conductivity (combined with temperature logs) for fluid flow; abundance and type of alteration minerals especially near magma chamber at EPR-1; geophysical properties (especially velocity) for ground truth of seismic horizons; delineation and identification of volcanic units; geochemistry for fractionation, changing magma sources, alteration, and mass flux into and out of basalt; modal mineralogy.

4. FMS and/or televiewer: refined delineation of volcanic units; quantitative fracture density, azimuth and aperture, and whether fractures are open or filled with secondary minerals; strike and dip of dikes (if any) and sills; fault imaging and possible detection of differential tilting across faults; style and geometry of large-scale porosity; imaging of alteration zones. Because the televiewer provides a 360° image, it will be generally superior to the FMS for these objectives. However, FMS will probably be much more sensitive to variations in alteration and may detect some features missed by televiewer. High priority for both. The dewared digital televiewer will require only modest hole cooling.

5. Packer/flowmeter: permeability (>10 m scale) for hydrothermal processes objective. High priority.

6. Magnetometer/susceptometer: in situ magnetic properties of very young oceanic crust, including effect of tectonic tilting and alteration; flow delineation. High priority. Gyro orientation will be needed for tectonic tilting objective.

7. Vertical seismic profile: high-resolution imaging of both top and bottom of the magma chamber at EPR-1 and 2; velocities more representative of seismic velocities than those obtainable from sonic logs. Can a three component VSP confirm a magma chamber, through absence of deep shear energy? High priority at EPR-1 on both legs, because of possible influence on subsequent drilling decisions.

8. Long-term experiments: see Leg Objective #4 above.

**LOGGING TOOL OBJECTIVES (assuming 4" DCS):**

The hydrothermal processes objective is severly impaired. Geochemical and magnetic properties objectives will be entirely dependent on core recovery. Key geophysical properties (velocity, magnetization) not obtainable; a sonic log can be run but velocities will be unreliable in pillows.

1. Temperature tool (high-temperature): identical to #1 above.

3. Fluid sampler: identical to #2 above.

3. Standard logs: large-scale porosity for comparison to permeability; delineation of some volcanic units.

4. Long-term experiments: see Leg Objective #4 above.

5. Packer/flowmeter: is it feasible to set the packer in casing and log permeability with a slimhole high-T flowmeter?

**NEED FOR NEW DOWNHOLE MEASUREMENT TECHNOLOGIES:**

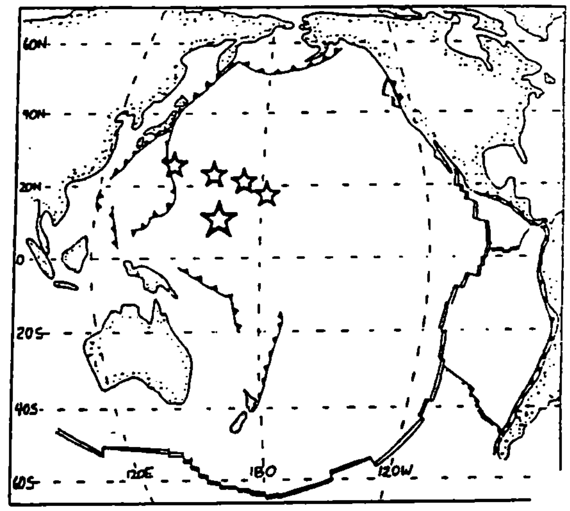
High-temperature logging cable. Slimhole, high temperature (400°C) logging tools, or cooling hole for standard tools. Temperature and fluid sampling tools reliable to 400°C. Design and development of long-term formation monitoring equipment and devices for hole-sealing.

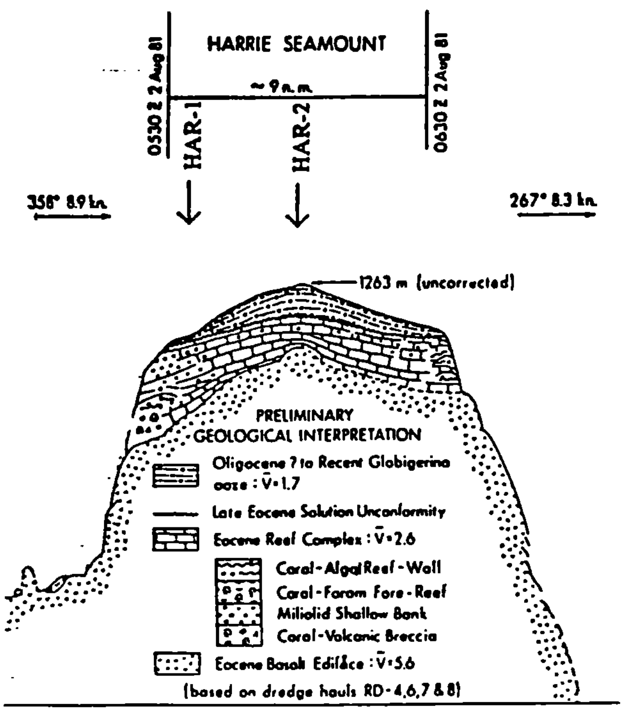
## Atolls and Guyots

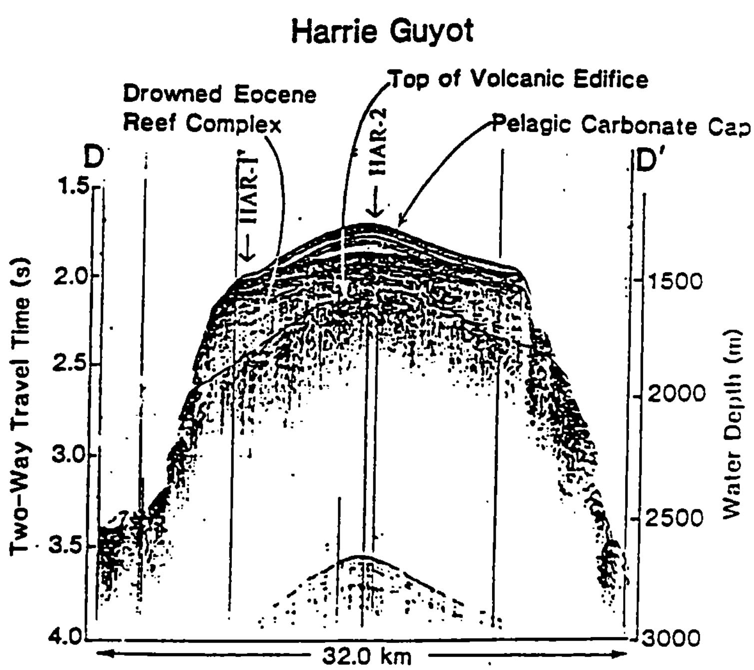
The timing and magnitudes of Tertiary sea level fluctuations can be studied on continental margins (e.g. Vail; Great Barrier Reef leg). However, these apparent sea level variations are a convolution of a "margin response" with actual eustatic sea levels, and the two factors have not been separated unambiguously. An alternative approach, used here, is to study the record of sea level variations in a drowned atoll. Both Cretaceous and Eocene reefs will be drilled, to date sea level changes and determine the causes of reef demise.

A detailed planning group will meet soon to develop a two-leg program consisting of most of the sites listed below.

Logging on this leg is likely to make only a modest contribution to the many cruise objectives: Late Cretaceous to Eocene sea level changes (nominally Late Cretaceous to Recent, but post-Eocene sedimentation is open-ocean pelagic), anatomy of reef facies in drowned atolls, timing and cause of atoll drowning, subsidence rates, chronology of volcanic events, paleolatitudes, and Early Cretaceous to Paleogene faunas.



| Site I.D.. | Water Depth | Penetration Sed. | Bsmt. | |
|---|---|---|---|---|
| Maj-1 | 4125 | 875 | 50 R | archipelagic apron of Cretaceous atoll |
| Har-1 | 1500 | 400 | 50 | summit of drowned Eocene atoll |
| Har-2 | 1300 | 300 | 150 R | summit of drowned Eocene atoll |
| Pel-3 | 1080 | 130 | 20 | summit of drowned atoll |
| Syl-1 | 1350 | 200 | 150 R | summit of drowned Cretaceous atoll |
| Syl-2 | 1350 | 200 | 50 | summit of drowned Cretaceous atoll |
| Syl-2A | 1350 | 200 | 50 | summit of drowned Cretaceous atoll |
| Syl-3 | 4800 | 800 | 125 R | archipelagic apron of Cretaceous atoll |
| Allison | 1440 | 750 | -- | summit of drowned Cretaceous atoll |
| M.I.T. | 1330 | 300 | -- | summit of drowned Cretaceous atoll |
| Caprina A | 1610 | 150 | -- | summit of drowned Cretaceous atoll |
| Caprina B | 1600 | 300 | -- | summit of drowned Cretaceous atoll |
| C. Johnson A | 1800 | 150 | 100 | summit of drowned Cretaceous atoll |
| C. Johnson B | 1750 | 250 | 50 | summit of drowned Cretaceous atoll |
| Huevo A | 1365 | 800 | 200 R | summit of drowned Cretaceous atoll |
| Huevo B | 1370 | 275 | -- | summit of drowned Cretaceous atoll |

**PREVIOUS PLANS FOR LOGGING:**

Never evaluated by DMP. Proponents included standard logging or sonic and density logging for all sites except shallow PEL-3 and Caprina A.

**LEG OBJECTIVES:**

1. Diagenetic history of the coral caps, a likely recorder of sea-level fluctuations. Sea-level changes have diagenetically overprinted the original carbonate porosity structure of the reefs, via solution and precipitation of calcite and dolomite. Standard logs can be used to calculate logs of porosity, calcite percentage, and dolomite percentage. Coupled with isotopic and petrographic data from cores, these logs should help to unravel the complex diagenetic histories of the reefs. On Leg 133 (NE Australia), FMS detected characteristic diagenetic signatures of sea-level fall.

2. Detection of sea-level falls, through identification of reef-derived turbidites in the archipelagic apron sites. Thick (>2m) turbidites are readily delineated with standard logs, and the FMS is particularly good at determining sedimentary facies and detecting porosity gradients in thin beds. However, the sea-level signal in the archipelagic apron may be as subtle as a trace of reef component in dominantly pelagic carbonate turbidites. Thus the logs may or may not be useful for this objective.

3. Basalt geochemistry. Dredging indicates that an unusual basalt composition (DUPAL) characterizes a seamount province that encompasses most of these seamounts, as well as many seamounts now being subducted at the western margin of the Pacific plate. Geochemistry of these basalts is a secondary cruise objective. Obtaining representative major-element geochemistry of these guyots also would contribute to calculations of geochemical budgets for arc volcanism. Standard logs would provide these continuous geochemical records.

4. Anatomy of reef and associated facies of drowned atolls. Reef facies are tentatively identified on seismic at most sites; synthetic seismograms from standard logs will compare these identifications to core and log-based ones. FMS can detect some variations among different reef facies. The major uncertainty is whether subsequent diagenesis has obscured the characteristic FMS signatures of the different facies.

**LOGGING TOOL OBJECTIVES:**

1. Standard logs: porosity and mineralogy (particularly calcite/dolomite) of reef deposits for reef diagenetic history; turbidite delineation and possible detection of a low-stand turbidite signature, for identification of sea-level signals in the archipelagic apron sites; basalt geochemistry for geochemical reference sites; synthetic seismograms at all sites for comparing within-site determinations of reef facies to seismic identifications of facies. Chances of success: fair to very good, depending on objective. Current uncertainty about the reliability of ODP magnesium logs should be resolved well before this leg; potential impact on the usefulness of geochemical logs on this leg is substantial.

2. FMS: delineation of reef facies; detection of diagenetic signature of sea-level change; turbidite delineation in the archipelagic aprons. Priority: moderate, because FMS will help to compensate for the anticipated <10% core recovery in reef facies.

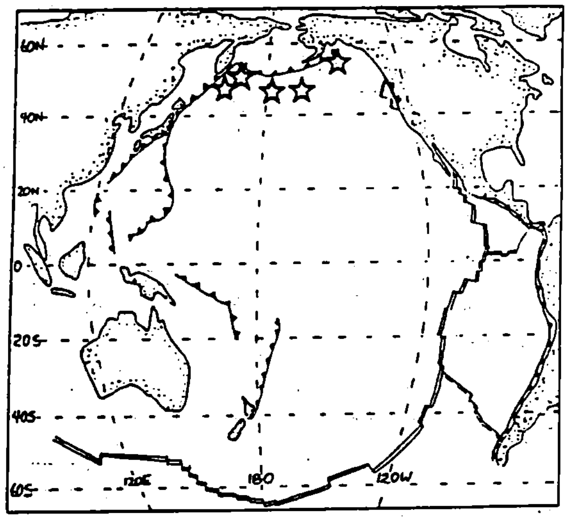
**NEED FOR NEW LOGGING TECHNOLOGIES:**

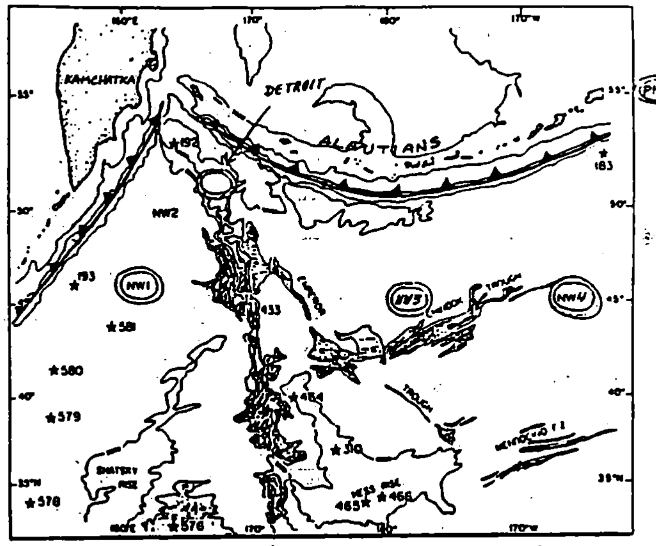
None.

## North Pacific Transect

Complementing the Neogene paleoclimate objectives of the Equatorial Pacific program, this North Pacific Transect program examines the effect of climate change on the Subarctic Front. Changes in surface ocean and atmospheric circulation, productivity, deep water circulation, continentally derived eolian material, and ice-rafted sediments can be examined in an E-W array of high-latitude Pacific sites.

All sites have nominal 50m basement penetration, but actual penetration is likely to be <10m with XCB, so no basement logging is likely. Penetrations at NW sites could be twice as large as indicated.




| Site I.D. | Water Depth | Penetration Sed. | Bsmt. | |
|---|---|---|---|---|
| DS-1 | 2400 | 500 | <50 | Neogene surface and deepwater history |
| DS-2 | 3100 | 500 | <50 | " " " " " |
| DS-3 | 3855 | <900 | -- | " " " " " |
| NW-1A | 5330 | 230? | <50 | Neogene climate, volcanism |
| NW-3A | 5800 | 100? | <50 | Neogene climate, eolian transport |
| NW-4A | 5685 | 100? | <50 | Neogene climate, eolian transport |
| PM-1 | 3660 | 310 | <50 | Neogene climate, surface-deep water history |

**PREVIOUS PLANS FOR LOGGING:**

Never evaluated by DMP. Proponents included quad and geochemical logging for all sites except shallowest ones.

LEG OBJECTIVES:

1. Changes in location of the Subarctic Front as a function of time. Both high and low frequency changes are anticipated, with a sedimentary signature of fluctuating carbonate and particularly diatom content. Calcite and opal logs, based on mineralogy determination from standard logs, will reflect when the Subarctic Front was over each site. Diatom abundance dominates physical properties logs (velocity, density, porosity, and resistivity); thus the FMS is likely to detect any fluctuations in diatom abundance, at Milankovitch or higher frequencies, resulting from changes in location or intensity of Subarctic Front upwelling.

2. Changes in atmospheric circulation as a function of time, as reflected in changing quantity and composition of eolian components. Clay mineralogy and possibly other non-biogenous mineral logs, based on mineralogy inversion of standard logs, will be very important for achieving this objective. In contrast, even an intensive XRD analysis of cores would provide only enough data to identify long-term changes in clay mineralogy.

3. Timing and nature of the middle Miocene shift from carbonate to siliceous pelagic sedimentation. Quantitative carbonate and opal logs will reveal the detailed character of this transition.

4. Temporal changes in carbonate dissolution, as a function of site depth (DS-1, 2, &3). Continuous intersite correlation via standard logs will yield continuous records of differential sedimentation rate at DS2 & 3, mapped against a DS-1 standard. When this intersite mapping function is applied to carbonate logs, the resulting log of differential carbonate "sedimentation" rates is effectively a log of depth-controlled differential carbonate dissolution rate (unless clay-mineral content varies between sites). If slumping has affected the stratigraphy at either site, the intersite correlation will reveal the anomaly. Better yet, FMS logs at the two sites would identify any slumped intervals and prevent possible misinterpretation of core data from such intervals. This is the same strategy, for the same purpose, used successfully on Leg 130.

5. Temporal and lateral changes in deposition of ice-rafted sediment. It is difficult for coring to recover a representative sample of ice-rafted particles larger than 3 mm, but the FMS has been shown to image individual grains in granites. Thus it is possible that the FMS could be used to image the sizes and abundances of coarse ice-rafted components. How to quantitatively analyze the FMS images in this context is less certain.

6. Stress direction. Though stress is not a stated leg objective, the geographic distribution of sites is very good for examining the effect of Aleutian-Alaskan subduction zone on the Pacific stress pattern. Chance of success: fair-poor; XCB basement penetration probably is not

sufficient for detection of basement breakouts, and overburden probably is too thin for shallow basement breakouts.

**LOGGING TOOL OBJECTIVES:**

1. Standard logs: calcite, opal, and physical properties logs for identification of both movements of the Subarctic Front and character of the transition from carbonate to siliceous sedimentation; clay mineralogy logs, for identifying influxes of arc-derived ash, changes in atmospheric circulation, and aridity/humidity variations in source regions of eolian components; intersite correlation (DS-1, 2 & 3) for differential carbonate dissolution. Chances of success: very good.

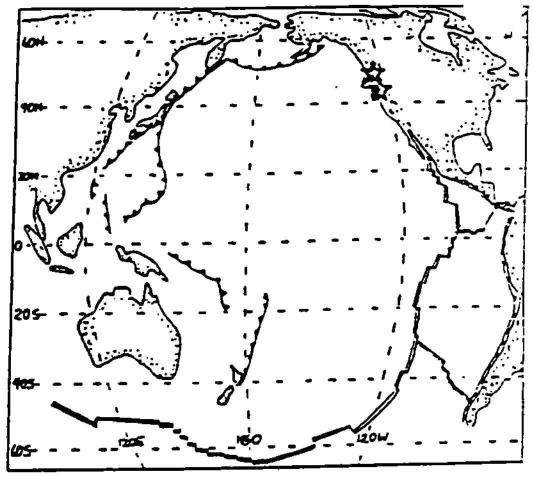
2. FMS: high-resolution record of diatom-induced porosity variations, possibly caused by Milankovitch forcing; slump detection (if present at DS-1, 2 & 3); variations in ice-rafted sediments; stress direction. Chance of success: uncertain; not known in advance whether slumps or Milankovitch porosity fluctuations will be present.

3. Borehole televiewer: stress direction. Low priority?

**NEED FOR NEW LOGGING TECHNOLOGIES:**

None.

## Cascadia Accretionary Prism



Recent major advances in our conceptual understanding of accretionary prism dynamics are badly in need of verification by drilling. Oregon and Vancouver Margins are thought to be accretionary prisms in which one can readily assess the effects of pore pressures, fluid transport, and fluid generation on deformation and particularly thrusting within the upper part of the accretionary prism. In both areas, the interplay of fluids and mechanical state appears to be the key.

This was originally two separate but complementary programs on the tectonics of accretionary prisms: a suite of holes examining fluid flow in the shallow sediments of the Oregon margin, and two deep holes examining structure and underplating at the decollement of Vancouver Island margin. The two programs were merged by the Cascadia Detailed Planning Group into two one-leg programs. Only the first leg is currently scheduled and considered here.

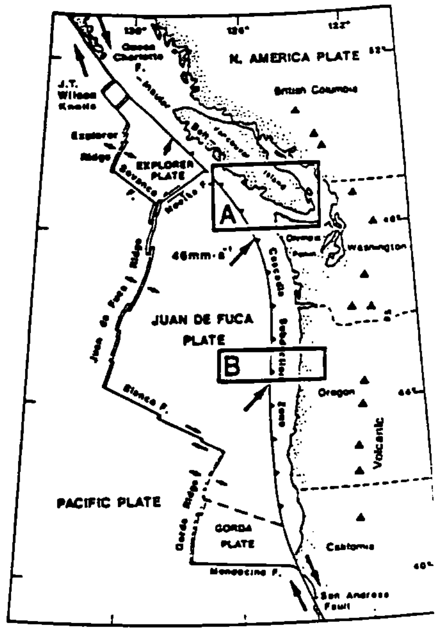



Figure 1. Continental margin of southweste: Canada and northwestern United States showing the plate-tectonic regime and main tectonic elements. (A) Vancouver Island margin and (B) Oregon margin study areas.

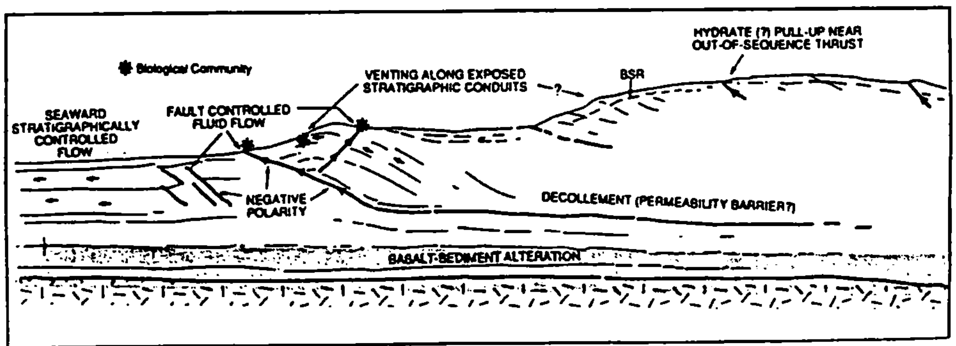



Figure 2. Conceptual cross sections showing geologic setting and possible fluid expulsion scenarios for central Oregon margin.

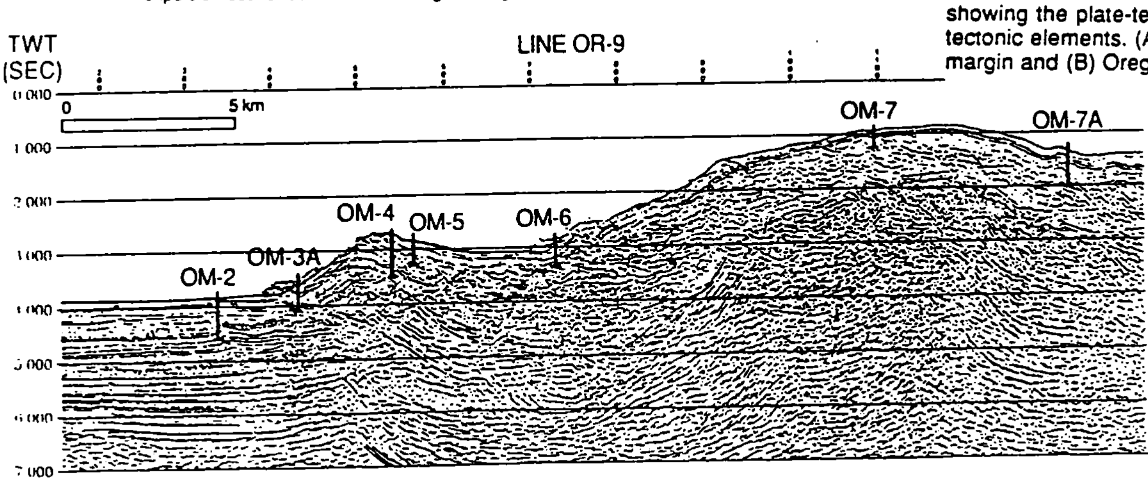



Figure 3. MCS line OR-9 showing drill sites OM-2, 3A, 4, 5, 6, 7, 7A crossing marginal ridge and second ridge.

## PREVIOUS PLANS FOR LOGGING:

DMP recommendations of 5/89 were used, along with associated time estimates by BRG, by the Cascadia Detailed Planning Group during their merger of programs for the two margins and development of a 1-leg program. Cascadia DPG downhole measurement plans are shown in the table below. In general, these plans are consistent with the DMP plans, except that the very time-consuming combination of geoprops plus wireline packer plus packer is consolidated into only three sites. The 2/8/91 ad hoc meeting of a DMP subgroup will consider hole conditions, a very important issue for downhole measurements in accretionary prisms.

Cascadia Accretionary Prism (DMP 5/89)

Scientific Objectives

Oregon Margin : present and past fluid expulsion processes, pathways, and effects in the several structural and stratigraphic settings ; chemistry, sources and diagenetic effects of the fluids.

Vancouver Margin : deformation at the leading edge of the decollement, geology and physical properties of the materials involved, flow of heat and fluids, long-term observatories.

Relevant DMP Thematic Thrusts

Intraplate stress
Long-term monitoring
Hydrogeology

Logging Programme

Nankai results are likely to guide the planning of this programme. Key issues are physical properties and fluid characteristics.

Each hole:

Standard logging suite (including (FMS)
Geoprops Probe every 30m to base of XCB (or wireline packer every 60m)
LAST every 30m in soft sediments
WSTP every 30m in upper sediments
Rotable packer (3 - 4 deployments/1000m)
Multichannel sonic (shear source) or Schlumberger array dipole tool

Deeper holes: OR-1, VI-1, VI-2

Additional measurements:

VSP
BHTV
Rotable packer (3 - 4 deployments/1000m)

Table 1. Cascadia I drilling and downhole measurement times (Cascadia DPG)

| SITE | PRIORITY | LOCATION | WATER DEPTH | PENETRATION | DRILL TIME (a) | STD logs + FMS (b) | WSTP 6 runs | CONE PLUG (c) | PACKER drill string | PACKER wire line | VSP | BH TV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI - 5 | 1 | 48°40'N 126°50'W | 1350 | 600 | 3.1 | 1.5 | 0.3 | 4.5 | 0.7 | 0.7 | 1.5 | 0.3 | 12.6 |
| VI -1 | 1 | 49°09'N 126°37'W | 2500 | 600 | 4.5 | 1.6 | 0.3 | - | - | - | - | - | 6.4 |
| VI -2d | 1 | 28°16'N 126°24'W | 2100 | 500 | 3.6 | 1.6 | 0.3 | - | - | - | 1.5 | - | 7.0 |
| VI - 3* | 2 | 48°19'N 126°17'W | 1350 | 500 | 3.1 | 1.5 | 0.3 | - | - | - | - | - | - |
| OM - 3 | 1 | 44° 38.53'N 125°19.55'W | 2655 | 540 | 3.5 | 1.7 | 0.3 | 4.5 | 0.7 | 0.7 | 1.5 | 0.3 | 13.2 |
| OM - 3A | 2 | 44°40.37'N 125°19.55'W | 2625 | 585 | 3.5 | 1.7 | 0.3 | 4.5 | 0.7 | 0.7 | 1.5 | 0.3 | - |
| OM - 7 | 1 | 44°40.38'N 125°07.34'W | 668 | 300 | 1.6 | 1.2 | 0.3 | - | - | - | - | | 3.1 |
| OM - 7A | 2 | 44°40.38'N 125°03.12'W | 1005 | 630 | 2.9 | 1.6 | 0.3 | - | - | - | - | | - |
| OM - 8 | 1 | 44°59.55'N 125°22.22'W | 2400 | 660 | 4.8 | 1.7 | 0.3 | - | - | - | - | | 6.8 |
| OM - 4+ | 1 | 44°40.37'N 125°19.69'W | 1020 | 700 | 4.6 | 1.7 | 0.3 | - | - | - | - | | 6.6 |
| OM - 2+ | 1 | 44°40.37'N 125°21.58'W | 2865 | 640 | 4.0 | 1.8 | 0.4 | - | - | - | - | | - |
| | | | | | | | | | | | | | 55.7 |

Total time (d): 57.7

a) Estimates for single hole, using APC/XCB to TD or bit destruction
b) Assumes SES
c) Includes time to drill hole B to 500 m, set casing, and install plug
d) Total time includes two extra days for additional downhole experiments (Geoprops/LAST)
* This Site to be regarded as alternate to Site VI - 5
\+ Only one Site between these two will be drilled depending upon the results of previous sites

**LEG OBJECTIVES:**

1. Pore pressure, permeability, and fluid flow at a variety of scales. These measurements will be used at both margins for determining hydraulic conditions, fluid expulsion pathways, and distinguishing intergranular flow from fault-plane flow. Measurement techniques will vary with depth and coring technique: LAST at shallow depth, geoprops for intermediate depths (NCB), wireline packer for greater depths (XCB or RCB), and packer only in the three sites with reentry cones.

2. Pore fluid composition, as an indicator of pore fluid origin, methane content, carbonate transfer and diagenesis, and fluid sources (e.g. compaction, subducted crust). Interstitial water sampling should be supplemented by in situ sampling, because methane will be lost from cores and because sands and fault zones may be most important for fluid flow but difficult to recover as uncontaminated cores. Use Barnes/Uyeda for shallow sediments and geoprops or wireline packer for deeper sediments, and pressure core sampler at various depths.

3. Porosity, both intergranular and fracture, for comparison with fluid-flow indicators and consequent evaluation of controls on fluid flow. Also for evaluation of effects of pore pressure and deformation on compaction. Standard logs (neutron, density, resistivity) and FMS.

4. Velocity, linked to both seismic and porosity. Velocity and density logs will provide a link between core depth and seismic traveltime through a synthetic seismogram. The direct controls on velocity (porosity and mineralogy) and their indirect causes (pore pressure and lithification) can be examined with interlog relationships. Together, these two links should provide nonunique but useful tools for interpreting the causes of lateral and vertical velocity variations detected by multichannel seismic and sonobuoys.

5. Temperature, heat flow, and thermal conductivity, as indicators of fluid flow and nonlinear thermal gradients. Shallow heat flow measurements will be based on the APC heat-flow shoe and Barnes/Uyeda probe. Continuous, high-resolution temperature logs will be a part of most logging runs, for extrapolation of equilibrium thermal gradients. Coupled with a thermal conductivity log from log-based mineralogy, the high-resolution thermal gradient log should detect nonlinear thermal gradients and all zones of active fluid flow. Heat flow and thermal gradients have implications for material balance in accretionary prisms.

6. Methane content of bottom simulating reflectors (BSR), for estimation of methane fluxes and for calibration of BSR lateral variations seen on seismic. Standard logs will detect clathrates. Barnes/Uyeda, geoprops, wireline packer, and pressure core barrel can provide fluid samples.

7. Detailed variations in structural dip, fault-zone delineation, and fracture patterns. Obtainable with FMS; televiewer possibly preferable for more lithified sediments because of its 360° imaging.

8. Mineralogy, both for depositional history of the margins and because of the probable impact of mineralogy (especially clay content) on hydrology. Obtainable from standard logs.

9. Sedimentary facies, particularly identification of slumps and turbidites, for depositional and structural histories of the margins. Obtainable primarily from FMS but also from standard logs.

10. Deployment of instruments at reentry sites, for long term monitoring of displacement, tilt, and changes in seismic velocity.

11. Stress and strain properties of sediments. Measurements of mechanical and stress state are needed to test models for the evolution of accretionary prisms. Stress measurements as a function of depth could increase understanding of why major earthquakes occur in subduction zones. However, in situ measurements of stress and strain properties are possible only for APC cores, using lateral stress tool. Maximum horizontal stress direction can be measured with FMS or televiewer.

12. Integrated major-element geochemistry for calculation of subducted elemental fluxes and comparison to arc petrogenesis. Obtainable from standard logs.

**LOGGING TOOL OBJECTIVES:**

1. Standard logs: fluid flow from temperature and thermal conductivity and from anomalous physical properties (porosity, velocity, density), link between core depth and seismic time, clathrate identification, mineralogy, major element geochemistry. Chances of success: very good.

2. FMS: structural dip, fault-zone delineation, fracture patterns, sedimentary facies, fracture porosity, stress direction (not a stated cruise objective). Chances of success: very good for first three, good for last three. However, FMS records may be poor for very unconsolidated sands, because of hole washout.

3. Wireline packer: pore fluid sampling and some pore fluid properties (e.g. Eh, Ph, T, resistivity). Chances of success; uncertain, limited ODP tests and uncertain development plans; sand caving may prevent adequate packing in some intervals.

4. Geoprops: pore fluid sampling, pore pressure, permeability, and temperature. Needs a Navidrill hole. Chances of success; uncertain, untested in ODP; sand caving may be a problem.

5. Lateral Stress Tool: lateral stress and strain, shear modulus. For shallow (APC) sediments. Chances of success: good, though few previous ODP tests.

6. Packer/flowmeter: large-scale (>10m) permeability and pore pressure. High priority for sites with reentry cones. Geoprops or wireline packer measurements may miss hydraulically most important zones; straddle packer will assure representative measurements. Some sediment intervals will be difficult to seal with the packer; flowmeter injection may be more feasible.

7. Borehole televiewer: complete imaging of fractures, faults, and deformation. Moderate priority, because objective partly achievable with FMS.

8. Barnes/Uyeda Probe: heat flow (Uyeda) as an indicator of fluid flow and other accretionary-prism processes, and fluid sampling (Barnes) for fluid geochemistry as a tracer of fluid history. Chances of success: very good for unlithified sediments (upper 400m), except for sands.

9. Pressure core sampler: gas (methane?) sampling of clathrates, fluid chemistry. Chance of success: uncertain, minimal ODP tests.

**NEED FOR NEW LOGGING TECHNOLOGIES:**

Several tools (FMS, wireline packer, geoprops, Navidrill, lateral stress tool, pressure core sampler, drilling packer) needed for this leg are still under development or have not been used in ODP yet. All probablly will be tested in ODP before this leg. One type of tool is potentially very valuable here but is not currently scheduled for development: a tool with the capability of determining consolidation, stress, and mechanical properties for sediments more lithified than those that can be studied with the lateral stress tool.