DRAFT

JOIDES Lithosphere Panel Meeting
Hawaii Institute of Geophysics
Univ. of Hawaii, Manoa
Honolulu, HI
2 March - 4 March 1988

EXECUTIVE SUMMARY

1.0 Evaluation of Proposal to Return to Site 735B (SWIR)

LITHP does not endorse a return to Site 735B at the present time. The panel was not convinced that the main stated objective of drilling Moho could be achieved in a single leg. There was also concern that this site will yield results representative of only one extreme end member of the accretionary spectrum and not "normal" oceanic crust. In terms of LITHP's long-term, global priorities, we would prefer drilling a site in a similar tectonic setting in the North Atlantic.

2.0 WPAC Planning

2.1 Geochemical Reference Holes

LITHP considered whether additional reference hole drilling could be integrated with CEPAC proposals and made the following recommendations:

(1) Sites MAR-4, 5 and 6 should be drilled on a single leg to be scheduled during the second year of WPAC drilling in FY90. These three, relatively shallow holes will sample the composition of the sediments entering the Marianas trench, and the summit and volcanoclastic apron of a large seamount typical of those being subducted at this arc.

(2) A second half-leg in the CEPAC program should be devoted to drilling site A2-2 east of the Bonin trench (replacing BON-8) on anomaly M-18. This hole should be drilled ~200m into basement. The second half of this leg should be used either to deepen this hole to 500m or to drill site J5 in the Jurassic Quiet Zone.

2.2 New Proposals

LITHP endorses proposal 298F to acquire VSP profiles in the Nankai Trough.

2.3 Co-chief Nominations

No WPAC co-chief nominations were made since the co-chiefs have apparently already been selected.

3.0 CEPAC Planning

3.1 Engineering Requirements

Engineering development required for CEPAC lithospheric drilling includes: (1) overcoming the rubble problem, (2) deep penetration, (3) high-temperature drilling, and (4) improved (>50%) recovery.

At least two engineering half-legs after 124E will be needed to test and evaluate new hard-rock drilling systems before EPR. At least one of these half-legs should be in the Lau Basin.

Including the engineering legs, at least 4 hard-rock guidebases will be required for CEPAC drilling.

3.2 Comments on PCOM's 18-month CEPAC Program

In order to properly address the scientific objectives of the three LITHP programs included in PCOM's tentative CEPAC schedule, at least 5 1/2 legs of drilling will be required. In addition, the proposed CEPAC program does not include any drilling of young hotspot volcanoes which LITHP considers an essential component of any lithospheric drilling program in the Pacific. Thus in our view, a core LITHP program in the CEPAC area consists of a minimum of 6 1/2 legs:

1 1/2	legs	504B
2	legs	EPR
2	legs	Juan de Fuca/Escanaba Trough
1	legs	Young hot spot volcanism (Loihi, Marquesas)
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6 1/2	legs	

LITHP also supports TECP and SOHP drilling programs in the M-Series/ Jurassic Quiet Zone and on Ontong-Java Plateau since these programs will have some lithospheric drilling objectives.

The following specific recommendations were made on CEPAC lithospheric drilling:

504B
* LITHP favors deviating the hole as the best option for deepening 504B
* We recommend an engineering half-leg at 504B early in the CEPAC program to prepare the hole for further drilling. This should be followed, if hole conditions warrant, by a full leg of scientific drilling.

EPR
* LITHP endorses the EPR Working Group's recommendation that the highest priority should be to drill a single, deep hole into the high-temperature reaction zone immediately above the magma chamber.
* The second priority should be a series of shallower holes (200-500m deep) across the rise axis.

* LITHP also endorses the site selection criteria and survey requirements developed by the EPR Working Group.

* Two legs of EPR drilling is adequate for this phase of CEPAC drilling, provided the engineering development legs proposed above are carried out. We recommend the two legs be separated by a minimum of 12 months.

Juan de Fuca Ridge/Escanaba Trough

* A minimum of two legs will be required to adequately address magmatic/hydrothermal processes, and questions related to ore genesis and sulfide deposition.

* At their second meeting the EPR Working Group should be asked to develop the existing drilling proposals for this area into an integrated drilling strategy for sedimented ridge crests (for this discussion a new working group chairman will be needed).

4.0 Long-Range Planning (1992 and beyond)

LITHP's highest long-term thematic objective is to determine the structure of the oceanic crust and how it forms. Mid-plate and convergent margin processes are important, but lower priority objectives.

Addressing LITHP's long-term thematic objectives will require drilling along two or three spreading ridges (slow and fast, sedimented and unsedimented), as well as one or more deep, crustal penetration holes off-axis on older crust.

The best locations for carrying out this drilling will be in the eastern Pacific (eg. EPR, Juan de Fuca Ridge) and in the North Atlantic (eg. MARK, Reykjanes Ridge). Thus, in the post-1992 time frame, LITHP sees its highest priority drilling objectives located primarily in the eastern Pacific and North Atlantic.

5.0 Other Matters

LITHP endorses LFASE at DSDP 417D/418A, but urges close collaboration with the TAMU engineers to minimize the risk to Hole 418A.

LITHP endorses the recommendations contained in the preliminary report of the PCOM Subcommittee on changes to the JOIDES Panel Structure.

Julian Pearce was appointed the new WPAC liaison.

The next LITHP meeting was tentatively scheduled for 12-17 Sept. in Corner Brook, Newfoundland. John Malpas will serve as host.

JOIDES Lithosphere Panel Meeting
Hawaii Institute of Geophysics
Univ. of Hawaii, Manoa
Honolulu, HI
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Members present:

R. Detrick (URI), Chairman
K. Becker (RSMAS)
K. Bostrom (ESF)
L. Cathles (Cornell)
H. Elderfield (UK)
T. Fujii (Japan)
J. Malpas (Canada)
M. McNutt (MIT)
C. Mevel (France)
J. Orcutt (SIO)
J. Pearce (UK)
M. Perfit (U. Florida)
N. Peterson (FRG)

In attendance:

E. Davis (CEPAC)
M. Fisk (SOP)
M. Kastner (PCOM)
S. Howard (TAMU)
J. Karson (ARP)
S. Scott (WPAC)

Absent:

R. Batiza (Northwestern)
S. Humphris (WHOI)
R. Duncan (IOP)
P. Robinson (PCOM)
J. Mutter (L-DGO)

AGENDA

1. Liaison Reports
2. Leg 118 Summary; Return to SWIR?
3. WPAC Planning
4. CEPAC Planning
5. Discussion of COSOD II recommendations
6. Long-range planning (1992 and beyond)
7. Other matters
   DSDP 418A and Wireline Acoustic/Seismic Exp.
   Panel advisory structure; liaisons
   Next Meeting

MINUTES

The meeting began shortly after 9 am with the introduction of several new panel members and the approval of the previously distributed meeting agenda.

1.0 Liaison Reports

1.1 PCOM (M. Kastner)

M. Kastner reported on the results of the last PCOM meeting in Sunriver, Oregon:

1.11 Engineering development

* PCOM emphasized the importance of improving communication between PCOM, the advisory panels and the TAMU Engineering Development Group. PCOM has appointed two "engineering watchdogs" (T. Francis, M. Langseth) to monitor engineering development efforts. An engineering liaison will be assigned to the thematic panels; for LITHP that liaison will be Steve Howard. There was a consensus on PCOM for scheduling one meeting per year at College Station to encourage exchange with the engineering group.

* PCOM has set aside 4% of the ODP operating budget for "special" projects; at least half of this amount is earmarked for new engineering development.

* PCOM has approved a 30-day engineering "half-leg" (Leg 124E) for testing and evaluation of new engineering systems. TAMU will present a proposal outlining what will be done on this leg to PCOM in April. Tools developed both inside and outside ODP/TAMU may be tested. Two more engineering "half-legs" may be scheduled later in the WPAC program after the Japan Sea legs and in the Lau Basin.

* Panels need to provide PCOM with long-term engineering development needs and leg-by-leg engineering requirements

1.12 Wireline logging

* Time estimates for standard Schlumberger logging on ODP legs should be based on three tool string runs without sidewall entry sub deployment.

* PCOM approved $160K for purchase of the Schlumberger formation microscanner; will be ready in about 11 months.

* PCOM approved testing of a wireline heave compensator for JOIDES RESOLUTION.

1.13 WPAC

* PCOM approved the first year of drilling for WPAC consisting of the following seven legs: Banda-Sulu-Celebes-South China Sea, Marianas-Bonin diapirs, Bonin Transect, Nankai accretionary prism, and two Japan Sea programs. Co-chief nominations are requested for the two Bonin legs, the Nankai, and Japan Sea legs.

* PCOM is considering 1 leg of reference hole drilling in the second year of the WPAC program; would like LITHP input on whether additional reference hole drilling could be integrated with CEAPC proposals to drill M-series anomalies or in the Jurassic Quiet Zone (285/E, 287/E).

* PCOM accepted LITHP recommendations on Lau Basin drilling

1.14 CEPAC

* For planning purposes, PCOM has drawn up an 18-month CEPAC drilling plan which it is sending back to the thematic panels for comment. This plan includes four LITHP legs (504B, EPR, and sedimented ridge crests), three SOHP legs (Neogene paleoenvironment, Mesozoic paleoceanography, Anoxic events), and two TECP legs (lithosphere flexure, ridge-trench interactions).

* PCOM would like feedback on what we can and can't achieve with this amount of drilling time in CEPAC and alternative programs in the event the highest priority programs cannot be drilled.

* PCOM approved the establishment of an EPR Working Group. Earl Davis (PGC) agreed to chair this committee.

* PCOM established "watchdogs" for the LITHP legs: 504B - John Malpas, EPR - T. Francis, Juan de Fuca - M. Langseth/M. Kastner.

1.15 Panel Advisory Structure

PCOM established a subcommittee consisting of Francis, Taira, Langseth and Heath to recommend changes to the present panel advisory structure. Their final report will be presented to PCOM in April. Preliminary recommendations include; (1) splitting SOHP into two panels, one for Ocean Paleoenvironment and Paleobiology, and the other for Diagenesis and Sediment Processes; (2) phasing out the regional panels and replacing them with ad-hoc Detailed Planning Groups focussed on specific thematic objectives; (3) external review of mature drilling proposals; (4) creation of a Shipboard Measurements Panel to oversee geochemical, geotechnical and other shipboard analytical techniques and capabilities.

1.16 ODP Publications

* ODP will continue to publish Vol. B, despite problems with it being considered "grey" literature. A five-person editorial board (2 co-chiefs, 1 TAMU editor, TAMU staff scientist, 1 outside scientist) will obtain external reviews and make publication decisions. The volume will

continue to be typeset, but no routine editing will be done except for non-English speaking authors. Figures must be camera-ready; no color plates unless paid for by the authors. Reprints will be limited to 50 per author.

* TAMU will try to identify "non-performers", especially co-chiefs, in order to insure that they do not participate on future ODP legs.

1.2 NSF Report (B. Malfait)

ODP has been approved through 1993; the drilling program for 1989-1993 will be reviewed this year. JOI has a budget of $35.5M for FY88 - $20.5M from NSF and $15M from the six international partners. Budget projections for the remaining years of the 10-yr program are:

FY 1989........	$36.0M
1990........	38.0M
1991........	39.0M
1992........	40.0M

These budget projections assume no new foreign partners; some increase in the partner contributions are assumed for FY90-92. Four percent of each annual budget will be set aside for "special" operations (guidebases, ice boats, mine coring system development etc.). Approximately half of this set aside and most of the annual budget increases are to be devoted to engineering development.

In FY88 NSF will support six drilling-related field programs and part of one other program. The plans to change to a more thematically driven program will not effect ODP funding of regional surveys as long as plans are made 3-4 yrs in advance.

1.3 WPAC Report (S. Scott)

As noted in the PCOM report, a six leg WPAC program has been approved for FY89 including an engineering half-leg in the Marianas Trough. Leg 124 (Banda/Sulu/SCS) is already in jeopardy because of clearance problems for drilling in Indonesian waters. Alternative sites may be proposed, but site survey data may be insufficient.

The Sunda program has been removed from the WPAC program because of lack of interest from TECP and clearance problems.

1.4 CEPAC Report (E. Davis)

CEPAC has not met since our joint meeting in Paris last Fall. They have prepared a 22-leg preliminary prospectus, part of which was distributed to the panel. CEPAC requests LITHP input on the following questions:

1) Are we satisfied with the 9-leg CEPAC drilling program proposed by PCOM? Does this decision affect our panel's drilling priorities?

2) Should a full leg be devoted to 504B, or should part of the leg be used to deploy guidebases at the EPR?

3) What is the favored engineering strategy for 504B?

4) Should the strategy developed by the EPR Working Group be followed?

5) Is a similar working needed to devise a drilling strategy for sedimented ridge crests?

6) LITHP input is needed regarding sitting of holes and basement penetration for SOHP Ontong-Java program and TECP/SOHP Old Pacific drilling.

Dave Rea is the new CEPAC chairman.

1.5 DMP (K. Becker)

USSAC will be sponsoring logging schools at the annual GSA meeting and at the Fall AGU meeting (Sunday before AGU) later this year. There will also be a special AGU session on ODP logging results, and a special JGR issue being organized by K. Becker. It was also noted that Brass and Kastner will be organizing a workshop on chemical logging.

2.0 SWIR - Results from Leg 118 and Proposal to Return to 735B

2.1 Scientific Results from Leg 118

Kier Becker summarized for the panel the results from Leg 118. The original objective of this leg was to drill directly into the upper mantle in the Atlantis II fracture zone where abyssal peridotites appear to be exposed at the sea floor. The highest priority site was on a median ridge within the transform valley. Several test spud-ins on this feature were unsuccessful, apparently due to a surficial rubble layer, and the site was abandoned. Several alternative sites were also occupied without success before the guidebase was finally deployed on a shallow platform in about 700m of water on the eastern rim of the Atlantis II fracture zone. This 11 my old site, which was not in the original prospectus for the leg, appears to be a wave-cut platform that exposes foliated and massive gabbro locally covered by sediment drifts.

The guidebase was set in about 26 hrs. In sixteen days of drilling 500m of gabbro were drilled with a remarkable **average** recovery rate of 87%. With the exception of one fine-grained diabase dike, all the rocks drilled are gabbros or metagabbros. Six separate lithologic units were recognized of olivine and Fe-Ti oxide-rich gabbro. Layered troctolites drilled near the bottom of the hole represent an early stage of the differentiation of mid-ocean ridge basalt and could indicate the hole is near the base of layer 3. Tectonically, the entire section drilled at 735B is a single coherent unit largely restricted to amphibolite facies metamorphism.

A complete suite of downhole logging measurements were made at this site. The entire hole was associated with very low porosities and surprisingly low temperatures. The layering in many of the gabbroic units was evident in the resistivity logs. A borehole packer experiment indicated low permeabilities below about 272 mbsf, with higher values above this depth. Compressional wave velocities are in the range of 6.5 to 7.0 km/s measured both <u>in situ</u> and on rock samples. A VSP experiment indicates a strong reflector ~500 m below the bottom of the hole.

2.2 Evaluation of Proposal 300/B - Return to Site 735B

The panel next considered a proposal submitted by Dick et al. to return to Site 735B before the drillship leaves the Indian Ocean later this year. The proponents argue that this site represents a unique opportunity to core the crust-mantle boundary where it has been uplifted and unroofed of layer 2 during the formation of the eastern fracture zone transverse ridge. Based on previous drilling at this site they expect 5-6 weeks of drilling could deepen this hole 1-2 km and "in all likelihood penetrate the oceanic mantle". Because of the importance of the structure of the lower oceanic crust to our understanding of the crustal accretion process, they argue this drilling should not be delayed until the ship returns again to the Indian Ocean.

The panel discussed this proposal at length. There was considerable excitement over the success of drilling at Site 735B and the potential significance of the results from this hole. The importance of the petrologic questions that could be answered by a section drilled through the base of the crust into the upper mantle was also clearly recognized by the panel. However, in evaluating this proposal the panel considered four critical questions: (1) What is the probability of achieving the stated goal of drilling into the mantle at this site? (2) How representative will this section be of "normal" oceanic crust? (3) Is this the best location to carry out this kind of drilling? (4) How does this drilling fit into longer-term LITHP global drilling priorities (discussed in part on Friday morning)?

(1) **Probability of drilling into the upper mantle.** The panel felt that a convincing case was not made in the proposal that Moho was achievable in a single leg. The VSP reflector noted in the proposal could have any one of several origins, and is not necessarily indicative of the crust-mantle boundary. It was noted that if the Moho is as shallow as the proponents claim, the transverse ridge should be associated with a free-air gravity anomaly of >1000 mGal. Gravity data were collected as part of the pre-drilling site survey, but none are shown in this proposal. Several panel members observed that in ophiolites the cumulate layering is frequently repetitive and the troctolites found in Unit 6 are not necessarily indicative of Moho. The cumulate gabbroic section could itself be 3-4 km thick. Recent seismic studies of transverse ridges along slow-slipping transforms in the North Atlantic (Vema, Kane, Charlie Gibbs) do not indicate these features are associated with exceptionally thin crust; Moho is found at approximately normal depths beneath these ridges. Unfortunately, comparable data are not available from the AII fracture zone, but given what is presently known the panel was not convinced that the main stated objective of this proposal could be achieved in 5-6 weeks of additional drilling, even if drilling conditions remained as optimal as they were on Leg 118.

(2) **How representative will this section be of oceanic crust?** Another question raised by the panel was how representative a hole at this site would be of "normal" oceanic crust. SWIR is in a relatively anomalous tectonic setting at the very slowest end of the accretionary spectrum along a ridge system dominated by horizontal shear. Although drill holes in this kind of environment will ultimately be valuable in understanding the range of accretionary processes, there is some doubt as to how far results from this site could be extrapolated to magmatic systems operating along more "normal" ridge segments. The proponents argue this site **is** representative of normal crust, but lacking detailed surface geological mapping and regional geophysics this assertion is difficult to evaluate. It was also noted that the absence of a basaltic section at this site, although an advantage in drilling, will make it impossible to study all three components of the magmatic system (extrusives, intrusives, and depleted source material) at this site leaving magmatic models somewhat unconstrained. Thus in the view of the panel, further drilling at Hole 735B will yield results that are representative of only one extreme end of the accretionary spectrum and will not necessarily answer many of the fundamental questions driving deep crustal drilling.

(3) **Is this the best location to carry out this kind of drilling?** The success of drilling at Hole 735B does suggest a new strategy for deep crustal drilling in which thinner crust near fracture zones can be used as a window into the lower crust. As the proponents correctly point out, it may be years before the technology is available to drill through a complete crustal section, and in the interim drilling proximal to fracture zones, despite their anomalous tectonic setting, may be the only way of sampling the deeper levels of the oceanic crust. If Hole 735B were the only place in the world where this type of drilling could be carried out, then a strong argument could be made to do this drilling now, before the ship leaves the Indian Ocean. However, several panel members noted this is not the case. Gabbros are routinely found exposed at shallow crustal levels along plate boundaries accreting at velocities of less than 15 mm/yr, and at the Oceanographer and Kane fracture zones these exposures occur in a tectonic setting directly analogous to Site 735B. However, unlike SWIR these sites are located in well-studied areas which already possess a wide spectrum and geological and geophysical data at a range of scales. SWIR is totally lacking of this kind of integrated, geological and geophysical database within which to interpret the drilling results. Given its remote location, it is unlikely that SWIR will obtain this kind of high resolution data anytime soon. From this perspective, as well as the availability of the drillship, the North Atlantic is probably a far better area to carry out this kind of drilling.

(4) **Role of 735B in long-term, global LITHP priorities.** Both COSOD I and II endorsed the concept of "natural laboratories" in which drilling is only one component of a long-term program of multidisciplinary investigations aimed at understanding how accretionary processes vary temporally and spatially. Developing meaningful three-dimensional models of accretionary systems in these areas will almost certainly involve drilling not just one hole, but a suite of holes both along and across-strike. Given our limited drilling resources, these natural laboratories will be

few in number and must be carefully selected to be representative of a range of accretionary environments. Because of its remote location and relatively anomalous accretionary environment, it is unlikely that SWIR will be chosen as one of these natural laboratories. Thus Hole 735B is likely to remain a hole in isolation, lacking for the foreseeable future, the complementary investigations and drilling that will be devoted to other areas along the Mid-Atlantic Ridge, EPR or Juan de Fuca Ridge. While this should not necessarily preclude future drilling at Hole 735B, it would be preferable if this type of drilling could be carried out as part of one of the established natural laboratories. Thus in terms of our panel's long-term, global drilling priorities SWIR does not rank high, despite the justifiable excitement over the drilling results from Hole 735B.

Based on the discussions summarized above, the consensus of LITHP was **not** to endorse a return to Hole 735B before the drillship leaves the Indian Ocean later this year.

2.3 Engineering Results from Leg 118

Steve Howard summarized for the panel the engineering results from Leg 118 and their impact on future hard-rock drilling.

* downhole motors were successful in spudding holes, but core recovery was very low in unconsolidated rubble

* SEDCO is now confident about deploying the guidebase; core recovery jumped from 2% to >35% after the guidebase was set; better recovery was also obtained when drilling was switched from the coring motors to the top drive

* 20-30 hrs of bit life can be expected in competent formations like those encountered at 504B or 735B; in young, fractured basalt like at 648B bit life drops dramatically (~8 hrs)

* average penetration rates are comparable at 504B, 735B and 648B (1.8-2.6 m/hr) indicating that these rates are not formation dependent

* average recovery rates at 735B were substantially higher (~90%) than at either 504B (24%) or 648B (12%) probably reflecting the massive, unfractured character of the gabbroic rocks

* the success in Hole 735B should not obscure the fact that major problems still exist with drilling in young, fractured rock; also problems exist with drilling and recovery rates in 504B that may require new crustal drilling technology

There was some discussion of new bit designs as a means of improving recovery rates. Howard noted that on Leg 118 a large-kerf diamond bit was tried, but it obtained only 6" of core in 2 hrs. He explained that diamond bits are more brittle than rollar-cone bits and thus more sensitive to heave. Smaller-kerf diamond bits would be used in the proposed mine coring system.

Howard suggested that a smaller, cheaper guidebase could be constructed based on the combined experience of Legs 106 and 118. Kastner pointed out that PCOM did not consider this a high engineering priority. Howard replied that new guidebases have to built for EPR and the changes envisioned would not represent a major redesign.

Bostrom asked if drilling using a bottom-lander had been considered. Apparently this technique has been successfully used in Swedish fjords. Howard pointed out that in great water depths and for >1000 m of penetration this technology would not be practical.

3.0 WPAC Planning

3.1 Geochemical reference holes

PCOM is considering 1 leg of reference hole drilling in the second year of the WPAC program and would like LITHP input on whether additional reference hole drilling could be integrated with CEAPC proposals to drill the M-series anomalies or the Jurassic Quiet Zone (285/E, 287/E).

At our last meeting, we recommended a minimum reference hole drilling program of one deep hole outboard of the Bonins (BON-8) and three shallower holes near the Mariana transect of DSDP Legs 59 and 60. This program requires 1 1/2 legs of drilling. Although LITHP has highly rated the Jurassic Quiet Zone proposal (287/E), this drilling cannot be integrated easily with the proposed geochemical reference holes. On the other hand, site A2-2 on anomaly M-18 in the M-series proposal (285/E) east of the Bonins could substitute for the single deep hole proposed at BON-8. There was some debate on the panel as to how deep this hole should be. The consensus was that it should be a minimum of 200m deep, preferably as deep as 500m, to satisfy the objectives of both programs. There was also some discussion about the location of a major fracture zone between A2-2 and the Bonin trench, but this was not considered a major problem since the first order question of the contribution of subducting crust to arc volcanics can still be addressed by drilling at this site. While LITHP has rated the calibration of the age of the M-series anomalies highly, we are not supportive of a second hole, as proposed by Handschumacher et al., to investigate along-strike variations in crustal magnetization along an M-series lineation. We would thus rank the drilling of a 200-500m deep hole in the Jurassic Quiet Zone much higher than a second hole along an M-series lineation.

Based on these discussions we make the following recommendations:

(1) Sites MAR-4, 5 and 6 should be drilled on a single leg to be scheduled during the second year of WPAC drilling in FY90. These three, relatively shallow holes would sample the composition of the sediments entering the Mariana trench, and the summit and volcanoclastic apron of a large seamount typical of those being subducted at this arc.

(2) A second half-leg in the CEPAC program should be devoted to drilling site A2-2 east of the Bonin trench (replacing BON-8) on anomaly

M-18. This hole should be drilled ~200 m into basement. The second half of this leg should be used either to deepen this hole to 500m or to drill site J5 in the Jurassic Quiet Zone.

3.2 Co-chief nominations for WPAC legs

PCOM requested co-chief nominations by LITHP for the two Bonin legs, the Nankai, and Japan Sea legs. However, it was learned that co-chiefs for these legs had already been selected by TAMU, despite protestations by our PCOM liaison to the contrary. Not wishing to waste the panel's time, further consideration of this matter was dropped.

4.0 <u>CEPAC Planning</u>

4.1 Hard Rock Systems Engineering Development

Steve Howard briefed the panel on new hard rock coring systems under study by TAMU engineers. He presented three concepts being evaluated: (1) Navidrill, (2) Navidrill with downhole turbine, and (3) a top-drive mine coring system. The Navidrill was successfully tested on Leg 118 and continued development and testing are planned for future legs. The downhole-driven, turbine Navidrill system could drill significantly deeper holes, but would still be limited to a total penetration of about 250m. It would also require a large diameter hole for the turbine motor. The top-drive mine coring system may offer the greatest potential for future hard-rock drilling since the depth of penetration is limited only by drill string length (initially ~3000m). However, several important technical questions remain about the top drive system; in particular, the feasibility of two heave compensators, and whether or not the mining drill rod can withstand drilling-related bending stresses.

Howard also discussed possible solutions to the rubble drilling problem. Among the options being considered are a special tri-cone bit, drill-in casing, and percussion drilling. The usefulness of cementing was discussed; in some situations it was felt it may work, but in many highly fractured formations it may be of little value. Howard felt that some type of drill-in casing probably offers the best long-term solution to the rubble problem.

Detrick asked if adequate funding was available to support the development of these new systems. Malfait noted that much of the increase in the ODP budget is targeted for engineering development, but because the rest of the program will be close to level funded there will be pressure on the engineering budget. **The panel re-iterates that the development of these new systems are essential to LITHP drilling objectives, especially in CEPAC, and urges PCOM to insure that adequate funding and resources are available to carry out this development effort.**

4.2 EPR Working Group Report

E. Davis led a discussion of a draft report of the EPR Working Group (this report is included as Appendix A). The charge to this group was to provide LITHP and PCOM with recommendations for an EPR ridge crest drilling strategy. The working group met in February, 1988 in College Station, and their final report will be presented to PCOM in April.

The EPR Working Group proposed a suite of eight holes along and across a generic ridge segment (see accompanying figure). The entire program could take 4-6 legs of drilling. Their highest priority is to drill a single deep hole into the high temperature reaction zone immediately above the axial magma chamber. The location proposed for this hole is near the center of the ridge segment and over a well-defined axial reflector, but well outside the central zone of fissuring and normal faulting. The depth of penetration required is 1-1.5 km. This hole will probably require at least two legs of drilling. The second priority is a 500m deep hole, in the axial fissured zone, but not in an active discharge zone. The third and fourth priorities were a series of shallower holes along and across the rise axis, respectively.

The most important conclusions to emerge from LITHP's discussion of the working group report were the following:

* The panel endorsed the working group's recommendation that the highest priority should be to drill a single, deep (> 1 km) hole into the high-temperature reaction zone immediately above the magma chamber

* The panel felt the second priority should be a series of shallower holes (200-500m) across the rise axis, instead of the along-axis holes proposed by the working group. The rationale was that these holes were more directly related to the hydrothermal objectives of primary site

* Geochemical fluid sampling will be very important, but cannot be done at the time of drilling. The holes will have to be sealed for later fluid sampling and temperature measurements. Cl^{36} may be a useful tracer

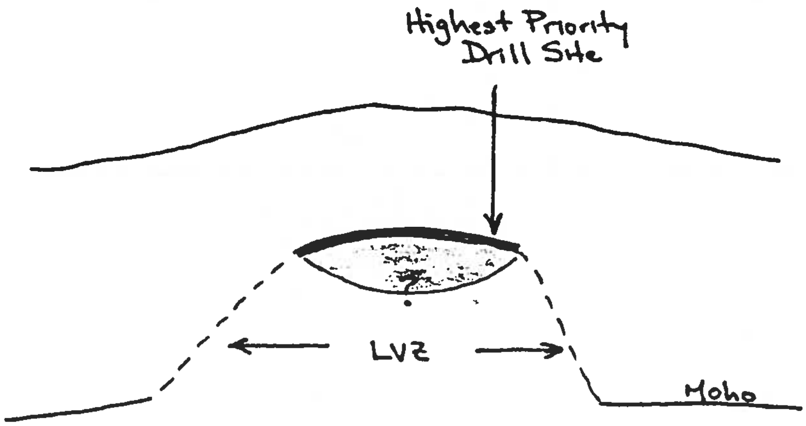
* Engineering development required for EPR drilling include: (1) overcoming the rubble problem, (2) deep penetration, (3) high temperature drilling, and (2) improved (>50%) recovery

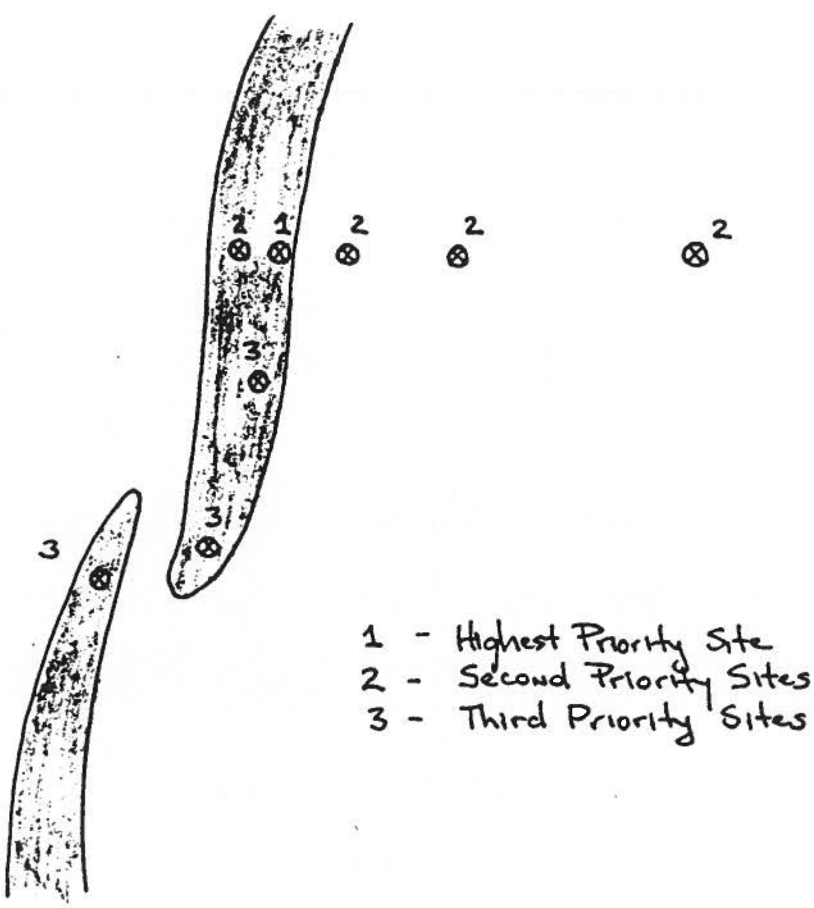
* Two or three engineering half-legs will be required before EPR drilling begins. Ideally the two EPR legs should be separated by 9-12 mo. (ie. the first leg should be scheduled early in the CEPAC program, the second leg toward the end of the CEPAC program)

* Including the engineering legs, 4 hard-rock guidebases will be required for CEPAC drilling

* The panel endorsed the working group's recommendation that if a minimum of 100-200m of penetration is not achievable, then the proposed EPR drilling should not go forward

PROPOSED EPR DRILLING STRATEGY





* The panel endorsed the site selection and survey requirements developed by the EPR Working Group. Based on these criteria the two most likely drilling areas are the 13^{o}N area, and the ridge segment south of the Clipperton Transform near 9^{o}30'N. Both areas are well-studied, but the 13^{o}N area lacks a well-defined axial reflector, while vigorous hydrothermal activity has yet to be found along the ridge segment south of Clipperton. Both areas require additional site survey information (surface mapping and water column studies in the 9^{o}30'N area; better geophysical data in the 13^{o}N area)

* LITHP found the EPR Working Group extremely useful and feels it should serve as a model for how thematic and regional interests can be combined in a thematically-driven drilling program

4.3 Evaluation of New Proposals

Three new proposals have been received since the last LITHP meeting.

1. Principal Horizontal Stress in the Oceanic Crust (66/F Revised)

This proposal is for a program of analastic strain recovery measurements on basalt and limestone samples from Leg 123. This will yield information on <u>in situ</u> stress directions and magnitudes that will be useful in determining lithospheric tectonic processes. The method is relatively simple, inexpensive and nondestructive to core material. The largest potential problem may be properly orienting core samples. This is potentially valuable addition to ODP physical property measurements which has LITHP support.

2. Oceanographic, climatic and volcanic evolution (247/E)

Drilling is proposed along a latitudinal drilling transect in sedimentary sequences and on seamount platforms and in pelagic areas in the NE Pacific. The objectives are primarily paleoceanographic, although some of the proposed holes would provide information on the age, composition and volcanic history of the Patton-Murray Seamount Group, as well as the tectonic evolution of the NE Pacific. Although the problems addressed are important, they do not rank highly among LITHP objectives in CEPAC. We would therefore classify this proposal in our Group 3 CEPAC proposals - "Limited LITHP interest".

3. Drilling in the Ross Sea, Antarctica (296/C)

Drilling is proposed in the Ross Sea to address three main topics: (1) rifting history of the Antarctic plate and uplift of the Transantarctic Mountains, (2) Mesozoic and Cenozoic Antarctic glacial history, and (3) Southern Ocean paleoceanography. Eight shallow and one deep hole are proposed. Sites 7,8 and 9 have some LITHP interest in terms of the first objective, however this program will driven primarily by SOHP and TECP objectives. We would also rank it in Group 3 as described above.

4.4 LITHP Response to PCOM's Proposed CEPAC Program

The panel next discussed PCOM's tentative plan for approximately 18 mo. of CEPAC drilling which includes 4 legs of LITHP interest: 504B (ca. 1 leg), EPR (ca. 2 legs), and Juan de Fuca Ridge/Escanaba Trough (ca. 1 leg). This discussion was focussed around two questions: (1) Has PCOM allocated enough drilling time to properly address the scientific objectives of these three programs? and (2) Are there important LITHP themes in the CEPAC area that are not addressed by this proposed 18 mo. program?

In order to address the first question the panel briefly reviewed the objectives and drilling time requirements for the three LITHP themes approved by PCOM for CEPAC drilling.

Deep Crustal Drilling (504B) - Kier Becker discussed the drilling problems at 504B. The catastrophic bit failures on Leg 111 may have several causes: (1) junk in the hole, (2) spalling of wall rocks, (3) inability to flush cuttings, and (4) formation properties. Becker questioned whether thermal stressing was the underlying problem. He noted that penetration and recovery rates on the first two bit runs on Leg 111 were quite good and suggested that junk and cuttings in the hole were the main problem. Conventional rotary coring may be successful at 504B _if_ the hole is properly cleaned (Kier pointed out that in its initial configuration the top-drive mine coring system will have a drill string length of only 3000m and could not be used at 504B which already is 5050m bsl). There appear to be two possible solutions to this problem: (1) deviating the hole around the junk, or (2) milling out the junk in the hole. Howard estimated milling the junk could take up to 6 weeks, and the hole still might not be completely clean. Deviating the hole is technically feasible and would take less time. Howard estimated that 2-3 weeks of drilling time would be required to deviate the hole in 504B.

Approximately one half-leg of engineering work will thus be required at 504B before drilling can proceed. LITHP believes a full leg of drilling is needed to have a reasonable chance of achieving the major scientific objective of reaching layer 3. The chances of success at 504B would be severely compromised by squeezing the engineering work and scientific drilling into only one leg. We thus recommend 1 1/2 legs be devoted to 504B.

Magmatic/Hydrothermal Processes at a Fast-Spreading, Sediment-Free Ridge Crest (EPR) - Although the drilling stragegy developed by the EPR Working Group may require 4-6 legs of drilling to complete, the panel felt 2 legs were adequate for the 1st phase of this drilling _provided_ at least two engineering half-legs were scheduled after 124E to test and develop new hard rock coring techniques. From an engineering perspective, Howard felt a spacing of about 12 mo. would be needed between these legs, meaning that the first EPR leg should be scheduled early in the CEPAC program and the second leg toward the end.

The panel is thus satisfied with the 2 legs allocated to EPR drilling planned by PCOM for this phase of CEPAC drilling.

Magmatic and Hydrothermal Processes at Sedimented Ridge Crests (Juan de Fuca Ridge/Escanaba Trough) - The panel did not have time at this meeting to discuss the scientific objectives and integration of the three proposals that address this important LITHP theme. However, the consensus of the panel was that a minimum of two legs would be required to adequately address magmatic/hydrothermal processes at sedimented ridge crests, and questions related to ore genesis and sulfide deposition.

At the second meeting of the EPR Working Group, LITHP would like to see the working group integrate these proposals into a coherent drilling strategy for sedimented ridge crests. For this discussion it will be necessary for the working group to have a new chairman (Davis is a proponent of drilling in this area) and the committee membership may have to be augmented somewhat to provide the necessary regional and thematic expertise in this area.

The second question considered by the panel was whether or not the proposed 18 mo. CEPAC program will leave out important LITHP drilling themes. The most obvious ommission in the proposed program is lack of any hotspot drilling. In fact, it is inconcievable that the drillship could pass through the Pacific without drilling a young hot spot volcano. Hot spot volcanism is a major global process which has played a particularly important role in the tectonic evolution of the Pacific. The early history of hot spot volcanos is a critical problem which can only be addressed in the Pacific. We have two highly rated proposals (Loihi - 282E; Marquesas - 291E) focussed on this problem and LITHP believes that at least one leg of drilling should be included in this phase of CEPAC drilling to address this problem.

There are two other CEPAC programs that will probably be driven by SOHP and TECP interests that LITHP also supports. These include the dating of M-series anomalies and Jurassic Quiet Zone crust in the western Pacific (discussed above in the context of Geochemical Reference Holes), and drilling of at least one large oceanic plateau in the Pacific, probably Ontong-Java. In both cases LITHP would support drilling one or more holes 100-500m into basement.

In summary, we believe a core LITHP program in the CEPAC area consists of a **minimum** of 6 1/2 legs:

1 1/2	legs	504B
2	legs	EPR
2	legs	Juan de Fuca/Escanaba
1	legs	Young hot spot volcanism (Loihi, Marquesas etc.)
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6 1/2	legs	

6.0 Long-Range Planning (1992 and beyond)

PCOM has asked the panels to look beyond the CEPAC program and develop their global thematic drilling priorities with a view toward defining where these problems can be best addressed.

LITHP began this discussion with a review of the COSOD II recommendations and the panel's response to those recommendations. Malpas expressed the view that the objectives in the LITHP White Paper and COSOD II are similar, except for the greater emphasis on geochemical mapping in the Working Group 2 report. Detrick pointed out that LITHP represents a broader community than Working Group 2; major lithopsheric drilling themes were also discussed by Working Groups 3 and 4 as well. There was agreement on the panel that the long-term LITHP objectives identified in our White Paper are consistent with the COSOD II recommendations. Cathles argued that ocean drilling was originally sold as a way of testing the plate tectonics paridigm. That has been done and the idea of global cycles - in climate and in the solid earth - provide a framework in which to continue ocean drilling. Peterson commented that the composition of the panels are constantly changing and therefore priorities will change. However, others felt the top 3 or 4 lithospheric drilling objectives will remain the same, although their relative ranking may change as individuals rotate on and off the panel.

In terms of post-1992 planning, the panel attempted to develop priorities within the framework of understanding the solid earth as a global geochemical system. There are three main components of this system that drilling can study: accretionary processes, mid-plate processes, and convergent margin processes. The panel felt the initial emphasis should be on accretionary processes - what is the structure of the oceanic crust and how is it formed? Addressing this objective requires drilling along two or three spreading ridges (slow and fast, sedimented and unsedimented), as well as one or more deep, crustal penetration holes off-axis on older crust. While the primary emphasis should be on these two drilling objectives, the panel recognized it will also want to support drilling which address other components of this system, if the objectives are consistent with the long-range goal of understanding global solid-earth geochemical cycles.

Where should this drilling be carried out? Lithospheric drilling will, of necessity, be focussed on a relatively small number of relatively deep, expensive holes. It is critical that these holes be concentrated in a few, well-studied, representative areas and that they be only one component of a long-term, multidisciplinary program of investigations. The best locations for carrying out this type of drilling effort will be in the eastern Pacific (eg. EPR, Juan de Fuca Ridge) and in the North Atlantic (eg. MARK, Reykjanes Ridge). Deep crustal drilling can potentially follow two different strategies: (1) drilling through the entire crustal section at sites like 504B or 418A, (2) drilling proximal to fracture zones where the deeper crustal levels may be exposed like at 735B on SWIR or near many large Atlantic fracture zones. Thus in the post-1992 time frame LITHP sees it highest priority drilling objectives located <u>primarily</u> in the eastern Pacific and North Atlantic, although some forays in the central and western Pacific or the Indian Ocean may be needed. A second circumnavigation of the drillship would definitely not be in the best interests of the lithospheric community.

7.0 Other Matters

7.1 LFASE - Low Frequency Acoustic Seismic Experiment

John Orcutt described LFASE, a borehole experiment designed to develop a better understanding of the physics of the excitation and propagation of low frequency noise (0.01-50 Hz) immediately above, at and below the seafloor (see Appendix B). The proposed work will be carried out in two stages. In the first stage, a caliper log will be run in the borehole and a seismic and acoustic sensor package lowered into the hole using a ROV. While the surface ship is still tethered to this package other ships will shoot a series of radial and circular seismic lines. In the second stage of the project, the surface ship will separate from the borehole sensor package and leave the area in order to record ambient noise levels. The seafloor recording package and the borehole sensors will be recovered after about 45 days of recording.

The experiment has fairly stringent site criteria which restrict the number of candidate holes. These criteria include deep water (>4000 m), thin sediments (>50m and <1000m), accessibility, and a nearby backup hole. The optimal location for this experiment is 417D, 418A south of Bermuda. Wireline re-entry is a new proceedure and there is some risk these operations could damage the hole or equipment could be left in the hole.

The panel discussed this situation, especially with respect to Hole 418A which is a valuable hole that is a candidate for deepening into the lower crust. In general, there was strong support for the development of wireline re-entry techniques and the utilization of existing boreholes for these types of experiments. The technology developed for LFASE will be valuable for future borehole experiments and long-term monitoring at holes like those proposed at the EPR. To minimize the risk to 418A, the panel urged close collaboration with the TAMU engineers with the possibility of designing sensor packages to facilitate retrieval from the hole.

7.2 Panel Advisory Structure

LITHP endorses the recommendations contained in the preliminary report of the PCOM Subcommittee on changes to the JOIDES Panel Structure.

7.3 Panel Membership

Julian Pearce was appointed the new WPAC liaison. J. Franklin will replace J. Malpas and J. Ertzinger will replace N. Peterson.

7.4 Next Meeting

The panel voted overwhelmingly (19-1) opposing the PCOM suggestion that every other panel meeting be held in College Station. College Station is difficult to reach and holds few attractions outside of Dudley's Draw, the Dixie Chicken and barbacue ribs. In many cases, like this LITHP meeting, it would be far more valuable for the engineers to travel to a meeting outside of College Station since they will be freed of the day-to-day distractions of the office and may have a chance to see places (like an active volcano) and meet people (like drillers from the Hawaiian Hydrothermal Project) that can give them a new perspective on their work.

In the spirit of this view, the next LITHP meeting was tentatively scheduled for 12-17 Sept. in Corner Brook, Newfoundland (including a 2-day field trip to the Bay of Islands ophiolite). John Malpas will serve as host.

APPENDIX A

DRAFT REPORT OF THE ODP EAST PACIFIC RISE WORKING GROUP

Prepared by the Working Group members:

Keir Becker
John Delaney
Bob Detrick
Earl Davis (Chairman)
Craig Forester
Jean Francheteau
Steve Howard
Ken Macdonald
Mike Mottl
Mike Perfit
Ralph Stephen
Rob Zierenberg

DRAFT SUMMARY

88-02-26

Guidelines

The objective of this working group is to provide the ODP planning structure with recommendations for an East Pacific Rise ridge-crest drilling strategy. The discussions were guided by the scientific objectives outlined in reports of preceeding planning groups, namely those of COSOD I, COSOD II, and the JOIDES Lithosphere Panel. The drilling strategy was developed with what are anticipated to be realistic engineering constraints in mind. It should be emphasised that many of these constraints will not be realistic unless major engineering developments devoted to improved crystalline rock drilling and recovery (currently in a mature planning phase) proceed in a timely fashion. Site-specific information was considered in the discussions of the group, but no single specific drilling site is explicitly favoured in the report. Instead, a suite of generic sites are proposed, and specific criteria for optimal site selection are presented.

Working hypotheses concerning ridgcrest magmatic, structural, and hydrothermal processes and their interrelationships are numerous, and require tests by several disciplines of marine science. ODP is just one of a number of tools that can be used to approach these problems, and there is a clear need to integrate many of the experiments that will be carried out in the ridge environment during the next decade. The program outlined here, already an integration of site survey experiments, core sampling, and short- and long-term down-hole observations, will hopefully be an integral part of a much broader sampling and observational program focused on a single ridge segment, with each tool used in an optimal way.

General Objectives

With these guidelines in mind, the following goals were considered to be of highest priority for an East Pacific Rise drilling program, particulary as they can be uniquely adressed by drilling:

1) To test the hypothesis that a reaction zone exists regionally above an axial magma chamber where fluids are in contact with high-temperature rock, and to observe the chemical and physical nature of the water-rock interaction there.

2) To characterize the physical and compositional structure of young oceanic crust.

3) To determine the temporal variability in the composition of magmas supplied to the ridge crest.

4) To "ground-truth" geophysical horizons that can be mapped widely and efficiently through remote seismic and/or electrical methods.

5) To characterize the way in which the oceanic crust is physically and chemically altered by prolonged hydrothermal circulation. (This problem requires additional drilling at older ridge-flank sites.)

<u>Strategy</u>

A suite of eight holes is proposed. Clearly, only a portion of this program can be completed in the time available during the upcoming phase of central and eastern Pacific drilling. Four to six legs may be required ultimately. All holes address high priority objectives, however, and it was felt that all portions of the broader program should be discussed and included in the current phase of planning. The holes can be grouped in order of their relative priority as follows:

1) The greatest technical challenge must be met with a hole that penetrates to a depth as close to the top of the axial magma chamber as possible. This hole should be situated near the centre of the ridge segment and over a clear axial seismic reflector, but well outside the central zone of active fissuring and normal faulting (i.e. 1 - 2 km off-axis). The depth of penetration required for this hole is roughly 1 - 1.5 km below the sea floor, about 4 km below sea level. Completion of this most difficult hole in two drilling legs would be considered a success.

2) A second hole should penetrate the upper crust of the axial fissured zone, but not into an active discharge zone. This hole should penetrate through the intrinsically permeable extrusive layer of the crust and far enough into the underlying dike complex to characterize the thermal field and possibly the permeability there. Completion of this hole will require approximately 500 m total penetration.

3) A pair of additional holes along the segment axis and a third hole on the adjacent overlapping segment axis will compliment holes 1) and 2) and provide an along axis petrologic and chemical transect for determining the nature of the temporal and spatial variability of lavas erupted along the axis of the segment from its centre to its distal end. These holes should be sited in a position similar to 1), but penetration only of the extrusive layer is required (approximately 300 m).

4) A second suite of three holes situated across the ridge segment summit will also compliment holes 1) and 2). This

transect will allow a longer time sample of the petrologic variability of a single ridge segment to be studied, although to a certain degree this can be approached through surface sampling. More importantly, it will allow the time-dependent hydrothermal alteration of the crust to be studied. The primary objectives can be reached again by drilling the extrusive section only (c. 300 m), although additional penetration into the upper 100 to 200 m of intrusive section would be valuable for chemical and hydrologic studies.

5) A hole in an axial discharge zone was considered to be a very high priority, but it was unanamously agreed that as yet, no discharge zone yet observed on the East Pacific Rise is sufficiently large or "mature" to warrent drilling. The objectives to be met with a hole or array of holes at a discharge site must be approached at another more suitable location.

<u>Criteria for Site Selection and Recommendations for Site Surveys</u>

Tectonic, magmatic, and hydrothermal processes at mid-ocean ridges are spatially and temporally variable, and are dependent on spreading rate. Thus there is no single "type" section. Certain characteristics are desirable, however, so that a focused drilling program can address the above problems well. The segment to be drilled should have:

1) Fast but not ultra-fast spreading rate. This and the need to be away from the magnetic equator requires that the program be located between 5 and 18 degrees north.

2) A strong, continuous, and shallow axial seismic reflector, suggesting the presence of a shallow crustal magma chamber.

3) Vigorous hydrothermal activity.

4) Simple topography, structure, and history.

5) A well defined overlapping rift offset on at least one distal end.

6) A well defined upper crustal reflector (inferred to be the base of the primary extrusive layer) beneath portions of the segment axis and flanks.

7) Relatively simple variations in basalt composition along the segment axis.

Perhaps more that any other program, the sucess of drilling relies heavily on segment and site characterization. Studies must range in scale from regional mapping (much of which is well in hand or underway) to detailed engineering-scale geophysical studies that can reduce the chances of spudding into highly incompetent formation. Time is short, and fortunately segment-scale investigations are numerous enough that the first decision, that of which ridge segment should be drilled, can be made with reasonable confidence soon. Concerted efforts then must be made to complete the necessary detailed surveys and sampling.

<u>Requirements for Engineering Developments</u>

None of the drilling proposed should be attempted with currently employed drilling technology. The following difficulties place new and challenging demands on ODP:

1) The upper section of young oceanic crust is known to be highly incompetent. Casing may need to be set in the upper tens of metres of this potentially rubbly material at every hole. Several hundred metres of penetration, with at least 50% recovery, are required at every hole.

2) The highest priority objective requires penetration and sampling to a depth of at least 1 km below the sea floor, approximately 4 km below sea level.

3) High temperatures will be encountered at depth in many of the holes. It must be anticipated that in the highest priority hole, formation temperatures will exceed 400 degree Centigrade. Mechanical and chemical consequences must be considered for drilling, sampling, and logging.

4) Due to the inability to observe in situ temperatures and pressures and to sample formation fluids in an open hole, a means by which the top of the holes (the deep axial hole as a minimum) can be sealed with sensors in place down the hole must be developed.

Adaptation of high-speed, narrow-kerf diamond drilling technique to the JOIDES Resolution is currently under study. This technique is used commonly in crystalline rock on land by the mineral exploration and geothermal industries, and it offers an excellent chance for dealing with many of the problems outlined above. A new departure such as this is the only way that will allow any of the high priority objectives outlined in this report to be met. It is essential that this and other necessary developments proceed rapidly and that adequate testing of new tools be executed before this East Pacific Rise drilling program begins.