JOIDES Lithosphere Panel Panel Meeting
Corner Brook, Newfoundland
13-15 September 1988

EXECUTIVE SUMMARY

1.0 LITHP Long Range Planning Document

The LITHP Long Range Planning Document was discussed at some length. Some minor, but significant, changes in the document were recommended by the panel:

- The importance of sea floor seismic observations as a long-range ODP goal in the coming decade was reaffirmed, but the definition of these observatories was broadened to include other types of long-term instrumentation. LITHP is particularly interested in the establishment of these observatories in conjunction with the ridge crest drilling planned in the Atlantic and eastern Pacific.
- The fourth drilling goal identified in the report was modified to be selected "case studies" of well-documented, representative features (e.g. a near-axis seamount or a back-arc spreading ridge) that are directly or indirectly related to our panel's highest priority thematic objectives. One such "case study" was recommended every other year.
- In addition to the EPR DPG, the panel recommends DPG's be set up for "Drilling Deep Crust" and "Sea Floor Observatories".
- Drilling Loihi should be included under Phase 1 as a lithospheric "case study".

The panel also addressed the four specific questions raised by PCOM about the LITHP long-range planning document:

Are 2 legs/yr enough for LITHP's highest priority drilling objectives? No. All **four** long-range drilling goals outlined in the report need to be addressed in the ten year program. In terms of level of effort, we estimate this will require the equivalent of about 1 leg/yr for deep crustal drilling, 1 leg/yr for ridge crest drilling, and about 1 leg/yr for establishing sea floor seismic observatories and carrying out selected lithospheric drilling "case studies". LITHP's interest in observatories clearly overlaps that of TECP, and at least some of the other lithospheric drilling discussed in the planning document could be carried out in conjunction with TECP, OHP or SAGP drilling, so the amount of dedicated LITHP drilling is probably about 2 1/2 legs per year.

What is LITHP fallback if new drilling technology is not available? There are numerous options depending on the specific circumstances. For example, if problems with young crustal drilling at the EPR can't be solved, it may be feasible to address the same thematic objectives at sedimented ridge crests where the crust is likely to be significantly altered and sealed. If drilling deep (>1-2 km) holes is not technically feasible then more emphasis could be placed on drilling exposed lower crust and upper mantle sections near fracture zones. Finally, a higher priority could be assigned to drilling technically feasible, secondary LITHP drilling objectives until the required drilling systems are available.

How are fluid interactions addressed in the report? Although fluid interactions are not broken out as a separate thematic objective in this report, they are obviously a critical component of both ridge crest drilling and deep crustal drilling. For example, the main focus of drilling at sedimented ridge crests is to develop a three-dimensional characterization of the fluid flow within a sediment-sealed hydrothermal system and the associated geochemical fluxes. Deep crustal drill holes would help constrain the depth of

hydrothermal circulation in the crust and, if holes are drilled in older ocean basins, the time integrated effect of fluid circulation on crustal alteration. Although fluid circulation at passive and active margins are also important targets for future drilling, they were not considered a high priority for LITHP and thus were not part of our long-range plan.

What is the relationship to other global initiatives? LITHP long-range drilling objectives are closely linked to a number of international research initiatives, especially RIDGE, as described in the planning document.

2.0 WPAC Planning

2.1 Geochemical reference holes

LITHP considered the potential scientific value of a one leg reference hole program and concluded that first-order information on the composition of the principal components being subducted at the Bonin and Mariana arcs can be obtained in a single leg of drilling, although the complete program as originally envisioned would require some drilling on a second leg. A realistic assessment of the magnitude and scale of heterogeneity in these components will require additional holes that could be drilled at a later date.

In priority order we recommend BON-8, MAR-4 and MAR-5. BON-8 and MAR-4 could probably be done in a single leg; MAR-5 or, an equivalent site, could be done in conjunction with Old Pacific Crust drilling in the CEPAC program.

2.2 Lau Basin drilling

The panel reviewed new SeaBeam and GLORIA data from the Lau Basin and made the following recommendations:

- A Lau Basin Working Group should meet to reconsider the Lau Basin drilling program in light of new Sea Beam and GLORIA data. The main task of the WG should be to take the thematic priorities for Lau Basin drilling already approved by PCOM and decide, in light of the new data, whether or not any sites should be moved. If possible, the WG should meet before WPAC in late October.
- LITHP's highest thematic priority in the Lau Basin remains the magmatic evolution and early rifting history of the basin. Thus LG-6 is a lower priority to LITHP than LG-3 or the back-arc basin sites. LITHP still considers Valu Fa (LG-4) an immature drilling target and favors a re-entry hole on young crust (but not a bare-rock site) in the central Lau Basin.
- The Lau Basin WG should consider moving LG-2 and LG-7 to a transect across the Eastern Lau Spreading Center from the Lau to Tonga Ridges, and explore ways (e.g. the upcoming Hawkins cruise) of obtaining any necessary site survey data.

3.0 CEPAC Planning

LITHP believes a minimum lithospheric drilling program in the Pacific should consist of 7 legs (including two engineering half-legs) addressing four of our panel's highest priority global thematic objectives:

Structure of the lower oceanic crust Hole 504B 1 1/2 legs
Proposal 286/E (includes 1/2 leg to clean or divert hole)

Magmatic/hydrothermal processes at sediment-free ridge crests EPR 2 1/2 legs
EPR Working Group Report (includes 1/2 leg to set guide bases)

Magmatic/hydrothermal processes at sedimented ridge crests Middle Valley 2 legs
EPR Working Group Report (also 232/E, 224/E, 284/E, 275/E)

Early evolution of hot spot volcanoes Loihi (282/E) 1 leg

504B

LITHP favors deviating the present hole, as opposed to milling the junk in the hole or redrilling the hole, as the best option for deepening 504B. If this is not successful, then consideration should be given to drilling other sites (e.g. 417A), before an attempt is made

to re-drill 504B.

EPR

Final site selection for EPR drilling should be done after site survey work is completed on the EPR south of Clipperton. This work is tentatively planned for the first half of 1989.

Sedimented Ridge Crests

The preliminary report of the EPR Working Group on sedimented ridge crests was extensively discussed by the panel. The two main drilling objectives proposed by the working group were approved by the panel: 1) a three-dimensional characterization of the fluid flow within a sedimented-sealed hydrothermal system and the associated geochemical fluxes, and 2) a systematic investigation of the processes involved in sulfide mineralization. The Middle Valley hydrogeology experiment proposed by the WG was strongly endorsed by LITHP as a well-conceived, process-oriented experiment that will provide unique new information on submarine hydrothermal systems. However, the panel recommended that the WG refocus the proposed sulfide drilling on a single, actively-forming sulfide area, well-known hydrologically, instead of sampling deposits in a variety of geologic and tectonic settings.

In summary, LITHP endorses a two-leg program of drilling at sedimented ridge crests: one leg for the Middle Valley hydrogeology experiment, a second leg focussed on actively forming sediment-hosted sulfide deposits, also in the Middle Valley area. A single-leg program would not be adequate to carry out both investigations.

CEPAC Engineering Requirements

- Four hardrock guidebases will be required for the LITHP drilling program recommended for the next phase of CEPAC drilling (2 EPR, 2 Loihi).
- LITHP recommends that PCOM direct the LDGO Borehole Research Group and DMP to develop a detailed plan, including technical requirements and costs, for the development of high-temperature logging tools that will be compatible with the Diamond Coring System under development by TAMU

4.0 Other Matters

4.1 Panel Membership

LITHP recommends Don Forsyth (alternates Phipps Morgan or Marc Parmentier) to replace Marcia McNutt on the panel, and Guy Smith (alternatives Paul Johnson or Morris Tivey) as a paleomagnetist to replace N. Petersen.

4.2 Next Meeting

The next LITHP meeting is tentatively scheduled for 28-30 March, 1989 in Miami (Kier Becker as host).

JOIDES Lithosphere Panel Panel Meeting
Corner Brook, Newfoundland
13-15 September 1988

Members present:

R. Detrick (URI), Chairman
R. Batiza (Northwestern)
K. Becker (RSMAS)
L. Cathles (Cornell)
J. Erzinger (FRG)
J. Franklin (Canada)
T. Fujii (Japan)
S. Humphris (WHOI)
J. Mutter (L-DGO)
J. Pearce (UK)
M. Perfit (U. Florida)

In attendance:

J. Karson (ARP)
R. Duncan (IOP)
J. Natland (WPAC)
J. Malpas (PCOM)

Absent:

K. Bostrom (ESF)
H. Elderfield (UK)
E. Davis (CEPAC)
M. Fisk (SOP)
M. McNutt (MIT)
C. Mevel (France)
J. Orcutt (SIO)

Agenda

1. Liaison Reports
2. LITHP Long Range Planning Document
3. WPAC Planning
4. CEPAC Planning
5. Other Matters
   a. Panel membership/chairmanship
   b. Next meeting

MINUTES

The meeting began shortly after 9 am with the introduction of several new panel members (Joerg Erzinger, Jim Franklin and Sue Humphris) and some discussion of the logistics for the post-meeting field trip to the Bay of Islands ophiolite arranged by John Malpas. John Mutter noted that there will be a meeting of Working Group #4 of the International Lithosphere Program on "The Nature and Evolution of the Oceanic Lithosphere" in Corner Brook on Sept. 18th and invited any interested LITHP members to attend. The ILP Working Group has recently been reorganized after a period of inactivity and John would like to encourage closer co-operation between ODP and other major international lithosphere programs.

1.0 Liaison Reports

1.1 PCOM (J. Malpas)

John Malpas reviewed the results of the August PCOM meeting. The Planning Committee approved important changes to the panel advisory structure. A new thematic panel was established on "Sedimentary and Geochemical Processes" and SOHP has been renamed the "Ocean History Panel". The regional panels are being phased out (except for WPAC and CEPAC) and will be replaced by Detailed Planning Groups such as the East Pacific Rise Working Group. Minor changes to the mandate of LITHP were made to reflect these changes in the panel structure.

PCOM was generally pleased with the LITHP Long Range Planning Document, particularly the phased implementation plan. A few questions were raised about the document which LITHP should address, namely: (1) Are 2 legs/yr enough for the highest priority LITHP objectives?, (2) What is the LITHP fallback if new drilling technology is not available?, (3) How are fluid interactions addressed in the report?, and (4) What is the relationship to other global initiatives?

PCOM has raised further questions about drilling geochemical reference holes in the western Pacific. Specifically, they want to know what can be learned with only one leg of drilling and are concerned with the scale of possible geochemical heterogeneity within and between holes. PCOM reviewed the CEPAC prospectus and examined the maturity of each program (see Appendix A). The top priority LITHP programs (504B, EPR, Sedimented Ridge Crests, and Loihi) generally faired quite well, but some minor questions need to be addressed.

PCOM approved a carefully worded resolution that post-1992 drilling will be thematically driven, and proposals for drilling in any part of the world are being solicited. LITHP commends PCOM on this enlightened approach to long-range drilling planning.

Australia has joined ODP in a consortium with Canada. Panel membership will be based on a 2/3 (Canada), 1/3 (Australia) arrangement.

1.2 IOP (R. Duncan)

Bob Duncan briefly summarized drilling results from the Indian Ocean legs of interest to LITHP: Leg 115 (Mascarene Plateau/ Chagos-Laccadive Ridge), Leg 118 (Southwest Indian Ridge), Legs 119/120 (Kerguelen Plateau/Gaussberg Ridge), and Leg 121

(90E/Broken Ridge). The IOP will meet for the last time in October and prepare a report on the Indian Ocean drilling and its thematic significance.

1.3 WPAC (J. Natland)

The first leg of the two year WPAC program will begin in November with Leg 124. The second year of WPAC drilling is still in the planning stage and will be finalized at WPAC and PCOM meetings later this Fall. Programs under consideration for this second year of drilling include Nankai geotechnical leg, Great Barrier Reef, Vanuatu, Lau Basin, Geochemical reference holes, and South China Sea margin. Consideration will be given to integrating some CEPAC programs (e.g. Ontong-Java Plateau, Old Pacific Crust) into this drilling. Clearances may pose problems for drilling in the Banda and South China Sea. New data is available from the Lau Basin which LITHP should review.

1.4 CEPAC (R. Batiza)

CEPAC prepared a drilling prospectus at its meeting in July. It contains 14 programs, ranging in length from 30 to 120 days, that represent the highest priority effort of each of the three thematic panels. PCOM reviewed the "maturity" of the programs in this prospectus at its last meeting (Appendix A) and CEPAC will meet again in late October to address theses questions and revise the prospectus.

1.5 DMP (K. Becker)

Kier Becker reported that DMP did not endorse the LPHASE experiment for DSDP 418A, despite the previous endorsement LITHP gave this program. DMP felt the experiment posed too great a risk to this hole, and favored moving the experiment to another site.

DMP also objected to the 4" diameter hole size planned for the Diamond Coring System (DCS) now under development by ODP. This hole size would be too small for many existing tools including the geochemical logging tool, magnetometer, borehole gravimeter, sonic logs and wireline packer. Apparently 3 5/8" tools require at least a 5" diameter hole. KTB is using a 6" diameter hole with their DCS. A discussion of this issue followed. It was pointed out that the 4" diameter hole was constrained by the diameter of the present drillstring. A 6" diameter DCS would require a costly new drillstring. One of the primary motivations for going to smaller hole sizes is the evidence that this will significantly improve hole stability and drilling rates in basaltic crust. This advantage would be lost by going back to large diameter holes. Finally, it was noted that most logging tools will have to be modified for high-temperature drilling in the CEPAC program anyhow, and it might be possible to slimline them at the same time. **The panel consensus was that PCOM should direct the LDGO Borehole Research Group and DMP to develop a detailed plan, including technical requirements and costs, for the development of high-temperature logging tools that will be compatible with the DCS.**

1.6 USSAC (K. Becker/R. Duncan)

Kier Becker and Bob Duncan reported on several items of interest from the last USSAC meeting. USSAC discussed the possibility of sponsoring a Lau Basin workshop to

evaluate present drilling plans in light of newly collected data (especially the recent GLORIA survey). Discussion of this suggestion was deferred to later in the meeting.

USSAC decided not to support the establishment of a national VSP laboratory as was recommended by a USSAC-sponsored VSP Workshop held last year. The rationale behind this decision was the view that VSP's should be a routine type of downhole measurement that should be a JOIDES responsibility, not that of a national lab. However, USSAC was willing to support the acquisition of VSP equipment which would be given to the Borehole Research Group.

USSAC has sponsored a synthesis of all available Sea Beam bathymetry, Sea MARC I side scan sonar, magnetics, gravity, seismic reflection and petrologic data from the East Pacific Rise between 16°N and 20°S. R. Detrick reported that the synthesis is nearly complete and an example of the synthesis folio will be on display in a USSAC booth at AGU. Support will be sought to publish this folio next year.

Finally, it was noted that USSAC has sponsored the production of a CD ROM with a complete compilation of DSDP data. These data are already available on 9T magnetic tape from the NGDC in Boulder.

2.0 LITHP Long Range Planning Document

The LITHP Long Range Planning Document was discussed at some length. A draft of this report was prepared over the summer and circulated to panel members by mail for comments. This was, however, the first opportunity for a full panel discussion of the recommendations in the report, especially the implementation plan. Several questions raised by PCOM about the long-range plan were also discussed.

The report was quite favorably received by the panel members, and it was agreed that the scientific objectives and priorities outlined in the report reflect the consensus of the entire panel. There was, however, some debate over the four long-range drilling goals identified in the report, especially the sea floor seismic observatories and the 50-100 holes recommended for mapping mantle geochemistry, determining lithospheric stress, and investigating magmatic processes at seamounts, aseismic ridges, oceanic plateaus and convergent margins.

L. Cathles questioned the scientific objectives of the seismic observatories and their relevance to LITHP's highest priority drilling goals. Will the observatories only be useful in determining global earth structure (e.g. lower mantle anisotropy, structure of the inner core) or can they be used to address problems more closely related to drilling (oceanic crustal structure, ridge crest tectonics, upper mantle dynamics)? Can the observatories be equipped with other types of instrumentation other than broad-band seismometers? What sort of long-range commitment would be required to maintain and service the instruments?

It was pointed out that many of these questions were addressed at a USSAC-sponsored workshop at Woods Hole in April. The value of seismic observatories was defended by J. Mutter and R. Detrick. They argued that the observatories would also be extremely useful for investigating oceanic crustal structure and ridge crest tectonics through studies of earthquake source mechanisms. Servicing of the instruments would be done by wireline re-entry and would not require the drillship. R. Duncan noted that these observatories, supplemented by OBS, will be one of the few ways of studying mantle dynamics and addressing problems like melt migration beneath mid-ocean ridges. The consensus of the

panel after this discussion was that the establishment of 15-20 sea floor geophysical observatories equipped with broad-band seismometers and other instrumentation (tiltmeters, strainmeters etc.) is closely linked to LITHP's highest priority scientific objectives and should be an important goal of ODP in the coming decade. LITHP is particularly interested in the establishment of observatories in conjunction with the ridge crest "natural laboratories" planned in the Atlantic and eastern Pacific.

The fourth long-range drilling goal identified in the report was discussed next. Several panel members questioned the feasibility and scientific rationale of the "grid-like" mantle geochemical mapping proposed at COSOD II. There followed a lively debate on what is meant by the term "geochemical mapping", and the role that drilling of secondary objectives should play in our long range drilling program. From this discussion there emerged a consensus on two points:

First, it was agreed that it would be a mistake, both scientifically and politically, to concentrate **all** lithospheric drilling over the next decade on only our two highest scientific objectives (deep crustal drilling and ridge crests). There are important, mature scientific problems included within our secondary priorities that can and should be addressed. Many are closely related to our top priority scientific goals. For example, drilling a near-axis seamount would complement a ridge axis drilling program and provide additional constraints on the magmatic plumbing system along an accreting plate boundary. Understanding hot spot volcanism and the geochemical fluxes at convergent plate boundaries would likewise provide new insight into the origin of the regional isotopic anomalies observed along the global mid-ocean ridge system.

Second, the panel agreed that the best approach to this type of drilling would be through selected "case studies" of well-documented, representative features around which new models can be tested. In many instances the panel felt this type of drilling could be integrated with drilling programs proposed by other thematic panels by extending selected holes into basement, adding an additional basement re-entry hole or other similar, relatively minor modification to an existing program. In the opinion of the panel, one such "case study" should be carried out at least every other year.

The panel next reviewed the phased implementation plan presented in the report. The general outline of the plan was accepted by the panel, although some minor changes were suggested. Under Phase 1 the panel agreed that, in addition to the present EPR Working Group, DPG's should should also be set up for "Drilling Deep Crust" (probably after the USSAC-sponsored workshop next Spring), and "Sea Floor Observatories" (in conjunction with TECP). Other DPG's should be established as needed. The panel also recommended that in Phase 1 one leg of drilling should be devoted to Loihi as one of the lithospheric "case studies" discussed above. In Phase 2 the panel recommended 3 legs/yr for lithospheric drilling; 1 leg/yr for drilling deep crust, 1 leg/yr for ridge crest drilling, and the equivalent of 1 leg/yr for establishing sea floor observatories and drilling selected lithospheric "case studies". In Phase 3 the panel recommended the equivalent of 1 1/2 legs/yr be devoted to extending one deep crustal hole to Moho, 1/2 leg/yr to ridge crest drilling, and 1-2 legs/yr to establishing the full suite of sea floor seismic observatories and carrying out selected lithospheric "case studies".

Having completed its own review of the long-range planning document, LITHP next addressed the four specific questions raised by PCOM about this document:

Are 2 legs/yr enough for LITHP's highest priority drilling objectives? The answer is no. In order to achieve LITHP's highest priority, long-term thematic objectives, and have a balanced program of lithospheric drilling, **all** four long-range drilling goals outlined in the report need to be addressed. In the view of the panel, the sea floor seismic observatories and drilling selected lithospheric "case studies" (e.g. a near-axis seamount or a back-arc spreading center) are closely linked to LITHP's highest priority thematic objectives of determining the composition and structure of oceanic crust and characterizing the processes of magma generation, crustal construction and hydrothermal circulation associated with crustal formation. In terms of level of effort, we estimate the equivalent of about 2 legs/yr should be devoted to deep crustal and ridge crest drilling, with about 1 leg/yr to establishing sea floor seismic observatories and carrying out other lithospheric drilling. LITHP's interest in observatories clearly overlaps that of TECP, and at least some of the other lithospheric drilling discussed in the planning document could be carried out in conjunction with TECP, OHP or SAGP drilling, so the amount of <u>dedicated</u> LITHP drilling is probably only 2-2 1/2 legs per year.

What is LITHP fallback if new drilling technology is not available? There are numerous options depending on the specific circumstances. For example, if problems with young crustal drilling at the EPR can't be solved, it may be feasible to address the same thematic objectives at sedimented ridge crests where the crust is likely to be significantly altered and sealed. If drilling deep (>1-2 km) holes is not technically feasible then more emphasis could be placed on drilling exposed lower crust and upper mantle sections near fracture zones. Finally, a higher priority could be assigned to drilling technically feasible, secondary LITHP drilling objectives until the required drilling systems are available. The panel will discuss these various options more fully at its next meeting.

How are fluid interactions addressed in the report? Although fluid interactions are not broken out as a separate thematic objective in this report, they are obviously a critical component of both ridge crest drilling and deep crustal drilling. For example, the main focus of drilling at sedimented ridge crests is to develop a three-dimensional characterization of the fluid flow within a sediment-sealed hydrothermal system and the associated geochemical fluxes. Deep crustal drill holes would help constrain the depth of hydrothermal circulation in the crust and, if holes are drilled in older ocean basins, the time integrated effect of fluid circulation on crustal alteration. Although fluid circulation at passive and active margins is also an important target for future drilling, they were not considered a high priority for LITHP and thus were not part of our long-range plan.

What is the relationship to other global initiatives? LITHP long-range drilling objectives are closely linked to a number of international research initiatives, especially RIDGE, as was described on p. 22 of the original planning document.

3.0 WPAC Planning

Two main issues regarding WPAC planning were discussed: (1) Geochemical reference holes, and (2) Lau Basin drilling.

Geochemical reference holes - PCOM has asked LITHP what can be learned from a one leg reference hole program. Jim Natland, LITHP's WPAC liaison and a proponent,

summarized the situation. A viable reference hole program requires sampling the three major components being subducted: 1) a normal, marine pelagic sequence, 2) normal oceanic crust, and 3) ocean-island lavas and volcanogenic sediments. At present, little is known about any of these components seaward of the Bonin and Mariana trenches. The best drilling strategy involves a single re-entry site at BON-8 to recover a normal pelagic sequence seaward of the Bonins and to penetrate ~500 m into basement, and two holes (e.g. MAR-5 and MAR-4) to sample sediments and a seamount apron seaward of the Mariana. These three holes would sample each of the three main subducted components thought to be important, as well as establish the differences between the two arc inputs. A seamount summit hole (e.g. MAR-6) to sample the ocean-island lava component would be desirable, but this component may be obtainable by dredging.

There was some discussion by the panel of the program outlined by Natland. In response to a question it was pointed out that each component (sediment, volcanics, altered crust) have distinct isotopic signatures that could be fingerprinted in arc lavas. Alteration products in the upper crust (e.g. K, Rb, oxygen isotopes) would be sampled by a 500 m deep hole and would be particularly diagnostic. It was also noted that basement drilling was important for other reasons; few samples of Mesozoic Pacific crust have ever been obtained. The consensus emerging from this discussion was that we don't have data now to answer even first-order questions about geochemical fluxes at convergent margins (e.g. why are the Bonin and Marianas arc lavas compositionally different ?, why do the Lesser Antilles arc lavas have a strong continental signature but Pacific arcs don't ?). The geochemical reference holes proposed for WPAC will not answer all of these questions, but they be a first step toward obtaining the first-order data needed to understand these processes.

This basic 3-hole program requires about 1 1/2 legs of drilling, as LITHP originally recommended to PCOM. Obviously, with only one leg this entire program cannot be completed, and other questions such as the scale of geochemical heterogeneity for each component cannot begin to be addressed. Drilling BON-8, together with a complete logging program, may require half to two-thirds of a leg. The remainder of this leg could drill MAR-4, but it would probably be necessary to drill a seamount apron target on another leg. Hemler seamount near PIG-2 in the Pigafetta Basin is a potential target that could be picked up during the Old Pacific Crust drilling proposed by Lancelot et al. (Proposal 306/E) and would be a suitable replacement for MAR-5.

To summarize, first-order information on the composition of the principal components being subducted at the Bonin and Marianas arcs <u>can</u> be obtained in a single leg of drilling, although the complete program as originally envisioned would require some drilling on a second leg. A realistic assessment of the scale and magnitude of heterogeneity in these components will require additional holes that could be drilled at a later date.

Lau Basin drilling - Julian Pierce summarized for the panel recent GLORIA results from the Lau Basin. The GLORIA records show that the Central Lau Spreading Center does not extend south of 19°30'S, and an Eastern Lau Spreading Center, juxtaposed against the Tonga Ridge, connects to the Valu Fa Ridge to the south. The Peggy Ridge in

the northern Lau Basin appears to be part of the Central Lau Spreading Center. Tectonically, the Central Lau Spreading Center is propagating south at the expense of the Eastern Lau Spreading Center. South of 19°30'S an abandoned spreading ridge is found west of the Eastern Lau Spreading Center.

In terms of the proposed Lau Basin drilling sites, LG-2 and LG-7 would still sample the early phase of basin opening and can be well-sited with reflection data. At LG-3 on the Tonga Ridge, unconformity A was not well-imaged on reflection profiles, but the sedimentary sequences above the unconformity are relatively undisturbed. Site LG-6 is characterized by relatively little sediment, but basement is reachable. Site LG-1 is close to the tip of the southward propagating Central Lau Spreading Center and its location may not be ideal.

The panel had a free-ranging discussion on these new results and the proposed drilling program. Some interest was expressed in the possibility of moving LG-2 and LG-7 south along a transect west of the Easter Lau Spreading Center, however lack of site survey data may not make this option feasible. The relative priority of the the arc (LG-3) and fore-arc (LG-6) sites was also debated. **Based on these discussions the panel made the following recommendations:**

- **A Lau Basin Working Group should meet to reconsider the Lau Basin drilling program in light of new Sea Beam and GLORIA data. The main task of the WG should be to take the thematic priorities for Lau Basin drilling already approved by PCOM and decide, in light of the new data, whether or not any sites should be moved. If possible, the WG should meet before WPAC.** ***[Postscript: A one-time meeting of a Lau Basin WG was approved by Pisias and they will meet at IOS before the end of October].***
- **LITHP's highest thematic priority in the Lau Basin remains the magmatic evolution and early rifting history of the basin. Thus LG-6 is a lower priority to LITHP than LG-3 or the back-arc basin sites. LITHP still considers Valu Fa (LG-4) an immature drilling target and favors a re-entry hole on young crust (but not a bare-rock site) in the central Lau Basin.**
- **The Lau Basin WG should consider moving LG-2 and LG-7 to a transect across the Eastern Lau Spreading Center from the Lau to Tonga Ridges, and explore ways (e.g. the upcoming Hawkins cruise) of obtaining and necessary site survey data.**

4.0 CEPAC Planning

John Malpas summarized the results of PCOM's evaluation of the first CEPAC prospectus (Appendix A). The highest priority LITHP programs (504B, EPR, Sedimented Ridge Crests, Loihi) generally faired pretty well, although PCOM had a few questions.

504B - PCOM asked for LITHP input on the scientific advantages of "twinning" (i.e. redrilling) 504B rather than diverting the present hole. The main advantages of redrilling 504B would be the possibility of recoring undersampled intervals, the possibility of hole-to-hole experiments and the ability to use the new DCS. However, the scientific value of hole-to-hole experiments in this setting have yet to be demonstrated and recoring would

significantly slow down drilling rates. To date, 125.5 total days of drilling and logging have been carried out at 504B, 79 days of drilling and 46 days of logging. In the most optimistic scenario, it will probably take 1-1 1/2 legs of drilling to reach the present depth of 504B with relatively little scientific gain. **LITHP thus favors deviating the present hole, as opposed to milling the junk or redrilling the hole as the best option for deepening 504B. If this is not successful, then consideration should be given to drilling other sites (e.g. 417A), before an attempt is made to re-drill 504B.**

EPR - PCOM requested a meeting of the EPR Working Group after Leg 124E to select specific drilling sites. However, additional site survey data on the EPR south of Clipperton is needed to make this decision. A proposal to carry out this work by Hamon, Fornari et al. has been funded and the field program will be carried out sometime in the first half of 1989. Final site selection should be deferred until after this cruise is completed.

The maximum temperatures that might be encountered during EPR drilling was discussed. It was agreed that 350-400°C remains a good estimate of the maximum temperatures that will be encountered within an active, axial hydrothermal system.

Sedimented Ridge Crests - The preliminary report of the EPR Working Group on sedimented ridge crest drilling was extensively discussed by the panel. The WG met July 26-28th at the Pacific Geoscience Center. The WG identified the two highest priority drilling objectives at sedimented ridge crests as:

- a three-dimensional characterization of the fluid flow within the hydrothermal system and the associated geochemical fluxes
- a systematic investigation of the processes involved in sulfide mineralization in a variety of geologic and tectonic settings

To address the first objective the WG proposed a hydrogeology experiment in Middle Valley on the Juan de Fuca Ridge consisting of a suite of six holes. The highest priority is a single basement re-entry hole which would have the objective of drilling into the high-temperature reaction zone of the active system. Complementing this hole is an array of five shallower holes to define the three-dimensional pattern of fluid flow over a 10 km x 20 km area. These holes are designed to penetrate into, but not substantially below, basement and would be located on areas of high and low heat flow within both active discharge and recharge zones.

To address the second objective the WG recommended a comparative drilling strategy to sample sulfide deposits in a variety of geologic and tectonic settings (e.g. Middle Valley, Escanaba Trough, and Guaymas Basin). In most areas, the WG proposed drilling 1-3 shallow, single-bit holes to depths of 200-300 m below the sea floor in the sulfide deposits.

The Middle Valley hydrogeology experiment proposed by the WG was strongly endorsed by LITHP. There was some discussion over the definition of a high-temperature reaction zone, but once this issue was clarified there was general agreement that this was a well-conceived, process-oriented experiment using the drillship that would provide unique new information on submarine hydrothermal systems. However, the panel had some

concerns over the sulfide drilling strategy proposed by the WG. L. Cathles, in particular, argued that it was extremely important to carry out studies of sulfide deposition in the context of a well-defined hydrogeological system. He thus felt that instead of drilling sulfides in a number of different areas, most with poorly characterized hydrothermal systems, it would be preferable to carry out the sulfide drilling one area, like Middle Valley, where the hydrogeology was well-known. Jim Franklin pointed out that the styles of sulfide mineralization vary from area to area, but conceded that the hydrogeology was essential to an understanding of sulfide genesis.

The panel thus agreed that the EPR WG should refocus the proposed sulfide drilling on a single, actively-forming sulfide area, well-known hydrogeologically, in order to completely document all aspects of the mineralization process. Later legs should be directed at obtaining similarly detailed data sets from at least one volcanic-hosted sulfide area, as well as other sediment-hosted deposits.

PCOM asked LITHP to consider the scientific objectives for both a one and two leg program at sedimented ridges. **Our recommendation is for a two-leg program: one leg for the Middle Valley hydrogeology experiment, a second leg focussed on actively forming sediment-hosted sulfide deposits, also in the Middle Valley area. A single-leg program would not be adequate to carry out both investigations.**

The panel also reviewed six new CEPAC drilling proposals received since the last LITHP meeting. The following is a brief summary of these discussions:

3/E Addendum Flexural moat drilling at Hawaii - This update to proposal 3/E to drill in the Hawaiian flexural moat summarizes the results of a number of recent surveys in this area. Evidence for recent volcanism has been found on the flexural arch surrounding the islands, and large-scale mass wasting has been shown to be a major input of sediments to the moat. LITHP's interest in a revised proposal broadening the drilling objectives to include these processes is solicited.

Some discussion followed on the geological significance of both the arch volcanism and the huge submarine landslides documented in these recent studies. The panel encourages a revised proposal and saw links between this program and drilling on Loihi.

222/E Ontong-Java Plateau - This proposal argues for making at least one of the holes drilled as part of the Ontong-Java depth transect (142/E Mayer and Berger) into a re-entry hole which is deepened at least 100 m into basement. This hole could provide information on the lithology, petrogenesis and age of the crust forming this plateau.

Some on the panel questioned how much information a 100-m basement hole would provide on the crustal structure of the plateau, however it was pointed out that just the basement age would be important in constraining some models for the origin of the plateau. A re-entry hole would also be available for deepening on later legs. The feasibility of this proposal could not be judged since the site survey for the paleodepth transect will not be collected until later this year (e.g. are there sites on this transect where basement can be reached, and where other site criteria can be met?). Final consideration of this proposal was therefore deferred to the next LITHP meeting.

305/E Arctic Ocean Drilling - This is a proposal for a multi-disciplinary drilling program in the Arctic Ocean. The objectives are primarily paleoceanographic and tectonic, but drilling on the Nansen-Gakkel Ridge, a slow spreading center, is also proposed.

The Nansen-Gakkel Ridge is of interest since it represents a slow spreading "end member" of crustal accretion. However, virtually nothing is known about the geological or geophysical structure of this ridge. This "end member" is better studied in the equatorial Atlantic or SWIR. The scientific rationale for an Arctic paleoceanographic drilling program is much stronger, but very little of the proposed drilling is practical with the *JOIDES Resolution.* It was pointed out that there will be a workshop next month on Arctic drilling and a separate Arctic drilling program may be proposed. This proposal would fall into Group 4 (Immature/serious deficiencies) of our CEPAC rankings.

306/E Old Pacific History - 1 2/3 drilling legs are proposed to recover Jurassic sediments and volcanic basement at six sites in the Pigafetta and East Mariana Basins of the western Pacific. These holes are designed to calibrate the geomagnetic time scale, sample mid-Cretaceous volcanic material, recover Late-Middle Jurassic age sediments and reach Jurassic basement.

For LITHP, the highest priority part of this program is reaching Jurassic basement and drilling at least to bit destruction into the crust. Jurassic-aged oceanic crust has never been recovered from the western Pacific and samples could provide key constraints on magmatic processes, mantle temperatures and composition in the Jurassic. This should be a re-entry hole to leave open the possibility of deepening it further at some later date. PIG-3 appears to be an ideal site based on data presented in the proposal. Sampling mid-Cretaceous volcanics is of lower priority; there is still much that can be learned about this volcanic event by dredging. The lowest priority for LITHP is dating the M-series anomalies.

As was previously noted in Detrick's memo of July 12 to Nick Pisias and Dave Rea, this drilling should not be viewed as "reference hole" drilling and therefore a substitute for the program proposed by Langmuir and Natland. However, if "reference hole" drilling is limited to one leg, there would be an opportunity to drill a volcanoclastic apron near site PIG-2 at Hemler or Dutton Seamounts. The proposal would fall into Group 2 of our CEPAC rankings (High, but with qualifications).

307/E Cross Seamount - The objectives of this proposal is to drill the carbonate cap and volcanics at Cross Seamount are twofold: 1) to study its subsidence and uplift history in relation to lithospheric flexure caused by the formation of the Hawaiian Islands, and 2) to determine the volcanic history and internal structure of a Cretaceous seamount.

A number of questions were raised about this proposal. Many centered around the flexure hypothesis proposed to explain the apparent uplift and recent subsidence of the island. Are the timing and magnitude of these vertical motions consistent with the Hawaiian flexural hypothesis? What about eustatic sea level changes? How would drilling at Cross Seamount help to refine or improve Hawaiian flexure models? Some simple flexural modeling could address these questions and is needed to justify the proposed drilling. LITHP felt the other objective, drilling to investigate the internal structure of a seamount, could be better addressed elsewhere. We would class this as a Group 4 proposal.

308/E Line Island drilling - This proposal is for drilling at several locations along the Line Islands to document reactiviation of volcanism along the chain, and to examine, in detail, the internal structure of a seamount.

In the view of the panel, reactivation of volcanism along the chain is a second order problem which does not rank as a high thematic priority for LITHP in the CEPAC area. The internal structure of a seamount is an important problem, but reactivation will complicate drilling in the Line Islands. It would be better to look at an individual seamount like Loihi or Seamount 6 first. The level of site documentation in this area was also inadequate. LITHP considers this an immature drilling proposal and would put it among our Group 4 proposals.

Summary

LITHP believes a minimum lithospheric drilling program in the Pacific should consist of 7 legs (including two engineering half-legs) addressing four of our panel's highest priority global thematic objectives:

Structure of the lower oceanic crust Hole 504B 11/2 legs
Proposal 286/E (includes 1/2 leg to clean or divert hole)

Magmatic/hydrothermal processes at sediment-free ridge crests EPR 2 1/2 legs
EPR Working Group Report (includes 1/2 leg to set guide bases)

Magmatic/hydrothermal processes at sedimented ridge crests Middle Valley 2 legs
EPR Working Group Report (also 232/E, 224/E, 284/E, 275/E)

Early evolution of hot spot volcanoes Loihi (282/E) 1 leg

5.0 Other Matters

Panel membership/chairmanship - Marcia McNutt has resigned from LITHP and a replacement with global geophysical interests in needed. Don Forsyth is the panel's first choice, with Phipps Morgan and Marc Parmentier as alternatives.

PCOM has also asked LITHP to nominate a paleomagnetist for the panel to replace N. Petersen. Our first choice is Guy Smith (Washington Univ.), with Paul Johnson and Morris Tivey as alternates.

R. Detrick has resigned as LITHP chairman, effective the end of this year. C. Langmuir and R. Batiza have been approved by PCOM as possible replacements. If neither of these candidates accept, the panel suggests Earl Davis, Dave Clague or Joe Cann as additional candidates. *[Rodey Batiza has agreed to take over the chairmanship of LITHP effective March, 1989].*

Next meeting - The next LITHP meeting was tentatively scheduled for 28-30 March, 1989 in Miami; Kier Becker will host. Tentative plans were also made to hold the Fall 1989 meeting in Europe to be hosted by ESF.

* * * *

The meeting offically adjourned at about 12:30 15 Sept. That afternoon, and on the following two days, John Malpas led the panel on a memorable field trip to the Bay of Islands ophiolite.

APPENDIX A.

JOIDES Planning Office

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6 September 1988

To: Chairmen of LITHP, SOHP, and TECP, CEPAC/dpg, EPR/dpg, FPAP/dpg
From: Nick Pisias, PCOM Chairman
Subject: PCOM initial evaluation of CEPAC Prospectus

At the Oxford PCOM meeting the Planning Committee discussed the status of the programs presented in the CEPAC Prospectus. In our discussions we concentrated only on those aspects of the Prospectus which were ranked by the Thematic Panels. PCOM examined the deficiencies identified by CEPAC and other panels and examined the "maturity" of each program. In the view of PCOM, we can only drill mature proposals and any program considered to be immature will not be considered for drilling until deficiencies are corrected. Based on the PCOM discussions the following issues need to be addressed by your panels:

1. In general, CEPAC should focus the prospectus to emphasize only the programs put forward by PCOM and the Thematic Panels.

2. **Flexure of the Lithosphere** - This program is considered immature with two major deficiencies: a) the resolution with which the sediments need to be dated to test different models of lithospheric flexure needs to be more precisely defined and b) information as to the ability to date sediments collected in the Hawaiian moat must be determined. TECP is asked to provide to CEPAC and PCOM an evaluation of the models and determine the criteria by which they can be differentiated and to examine the validity of the assumption of the models with respect to the loading history of the lithosphere. The proponents must provide evidence on the nature of the sediments and the degree to which they potentially can be dated. Site selection for this program needs to be evaluated in light of the new Gloria survey data from the region. CEPAC should consider requesting an updated proposal from the Proponents.

3. **Chile Triple Junction** - This is an immature proposal. The PCOM recognizes the importance of examining the collisional processes represented by this region. The existing proposal does not adequately define the drilling strategy required to address these problems. PCOM asks TECP and CEPAC to contact proponents to encourage the submission of a mature drilling proposal.

4. **Cascadia Accretionary Prism** - This is a very highly ranked theme but at present the proposals are immature. Input from the Detailed Planning Group on Accretionary Prisms is needed.

5. **Old Pacific: M-series dating and Jurassic Crust** - It is viewed by PCOM that the objective of dating anomaly M-18 is of lowest priority. Significant data is available for dating this anomaly. PCOM accepts

OCEAN DRILLING PROGRAM

the advice of the panels that geochemical reference drilling cannot be adequately covered by Old Pacific Drilling. Given the maturity of proposals for drilling in the Old Pacific CEPAC is asked to formulate a one leg mature program with Jurassic Quiet Zone and M-37 drilling to be the highest priority.

6. **Sea Level and Subsidence: Atolls and Guyots** - This program was not discussed in detail as the PCOM watch-dog was absent from the meeting. Based on the written input this program is worthy of a leg and remains immature until site specific information is provided by proponents. Drilling in this environment is likely to be extremely difficult. It is possible that logging could greatly enhance the success of this program if sediment recovery remains low. SOHP is asked to provide input as to the value of this program if recovery can not be greatly improved.

7. **Ontong Java Plateau Depth Transect** - This program is recognized as high priority but still remains an immature proposal. Given the upcoming site survey cruises this deficiency is expected to be corrected and this leg may possible be inserted in the early part of CEPAC drilling. CEPAC is asked to focus the discussion of Ontong Java drilling to the depth transect. Tectonic objectives have not been highly ranked and upcoming site survey work will not be able to add new insights on tectonic objectives.

8. **Neogene Paleoceanography of the Eastern Equatorial Pacific** - This is a nearly mature program. Site survey data is needed for the WEQ-1 and WEQ-2 sites. Logging and drilling time need to be updated; logging times seem to be overestimated by a factor of 2. SOHP is asked to examine the impact on this program if WEQ-1 and WEQ-2 cannot be drilled.

9. **North Pacific Neogene** - The sites in the northwest Pacific and central gyre seem to be adequate to address problems in this region. It is not clear that the objectives in the northeast Pacific can be addressed by a single site. SOHP needs to better define the objectives of this drilling program and how they are addressed by the proposed sites.

10. **Bering Sea High Latitude Paleoceanography** - This program is not sufficiently supported by the Thematic Panels and should be removed from the Prospectus.

11. **Shatsky Rise Anoxic Events** - PCOM recognizes the importance of understanding the nature and cause of anoxia in the world's oceans during the Cenozoic, however this program is considered immature. A number of questions arise with respect to this programs ability to test models of anoxia and to document changes in the oxygen minimum zone. Specifically: a) the SHAT-1 site may not be in the correct position to determine the paleo-position of the top of the oxygen minimum zone; b) Insufficient site survey data are available to determine the regional context of the proposed sites and whether the correct sections are represented in both sites and; c) severe technically difficulty is expected in drilling the chert/chalk sequences of the Shatsky Rise. SOHP and CEPAC are asked to determine if shallower sites can be found on the Shatsky Rise which have sufficient site surveys to be drilled. Results from Leg 124E will provide important information on our ability to drill in the environments expected on the Shatsky Rise. It is possible that logging could greatly enhance the success of this program if sediment

recovery remains low. SOHP is asked to provide input as to the value of this program if recovery can not be greatly improved.

12. **Lower Crust: Penetration of Layer 3** - PCOM recognizes the high priority objectives of this program and accepts the outlined 1.5 legs needed to solve the "junk" problem at site 504B, and then to deepen the site. LITHP is asked to provide some input on scientific advantages of twinning 504B rather than diverting the present hole.

13. **East Pacific Rise Bare Rock Drilling** - PCOM again recognizes the high priority objectives of this program. A meeting of the EPR/dpg is requested after the completion of the engineering Leg 124E. At this meeting the planning group is also asked to begin site selection for drilling on EPR and to address the question of what temperatures will be expected during the drilling of this program. It is viewed by PCOM that 400 degree temperatures are an underestimate if deep drilling is successful.

    Together 504B and EPR drilling are expected to require on the order of 3.5 legs of drilling exclusive of the engineering developments needed for the mining-coring system.

14. **Hydrothermal Processes at Sedimented Spreading Centers** - The extensive drilling times outlined in the Prospectus were not clearly justified. For example no justifications for triple APC was given. LITHP is asked to examine the input from the sedimented ridge working group. LITHP is asked to provide two options: a) what are the scientific objectives that can be achieved with a single leg program and b) what is the optimal two leg program? Finally, LITHP is asked to comment on sedimented ridge drilling in the case that bare-rock drilling on the EPR cannot be completed because of technical problems - i.e. Sediment ridges as a backup to EPR.

15. **Early Stages of Hot Spot Volcanism: Loihi** - PCOM watchers of the dogs were named for this program (M. Leinen and J. Malpas) and a report is expected for the next PCOM meeting. PCOM notes that in the four year program plan funds for the additional guide bases for this program are not included in the long range budget figures. LITHP is asked to define the number of guide bases and bare-rock sites it expects to require prior to the end of FY1992. Finally, the success of drilling on Loihi is fully dependent on our ability to drill in very young, fractured, hot rock.

cc: J. Malpas
U. von Rad
O. Eldholm
W. Coulbourn
R. Moberly
M. Kastner
G. Brass
T. Shipley
M. Leinen

APPENDIX B

THE 1989 LOW FREQUENCY ACOUSTIC-SEISMIC EXPERIMENT
2 March 1988

The Low Frequency Acoustic-Seismic Experiment (LFASE) is a scientific endeavor scheduled to take place in the spring of 1989. The major objective of this experiment is 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. In addition to these noise experiments, we shall conduct signal experiments using a variety of impulsive and oscillatory sources at the ocean surface. Data from these signal experiments will delimit the elastic properties of the bottom for use in the noise studies as well as provide unique data for understanding the attenuation of sound in the coupled ocean-seafloor system.

The investigators will develop and exploit a new ocean technology to locate and probe DSDP holes with a maneuverable, tethered deep submergence vehicle. Using this technology they will emplace a multi-node seismic sensor within the cased portion of DSDP borehole 418. The overall system will consist of the borehole, three-component inertial sensors and borehole hydrophones as well as ocean bottom seismographs and a vertical hydrophone array. The experiment will be preceded by a visit of the re-entry system to the borehole to determine the condition of the re-entry cone using sonar and photographic means as well as a re-entry of the hole with a caliper log.

The actual LFASE experiment will consist of two complementary stages. In the first stage, the R/V Melville will emplace the instrumentation on the seafloor and within the borehole while remaining coupled to the borehole seismic and acoustic sensors through the re-entry vehicle and its tether. Other ships will shoot a series of radial and circular lines using airguns, explosives and tuned sources to provide data required to characterize the seafloor including the sediments, crust and uppermost mantle. The subsequent data analyses will employ a full suite of techniques for determining the vertical elastic properties of the seafloor as well as the anisotropic behavior of the ocean crust and uppermost mantle.

The second stage of the experiment is designed to provide recordings of long time series of unadulterated seafloor noise in the absence of ships. The R/V Melville will divorce itself from the borehole sensors and return to port with the shooting ship. The ocean bottom seismographs and the borehole sensor recording systems are presently being modified to provide several gigabytes of recording capacity in order to allow nearly continuous seafloor recording. Data from all the sensors will be jointly examined to develop a full understanding of the noise at the bottom. The R/V Melville will return to the recording site after several weeks to recover the seafloor apparatus and extract the borehole array from DSDP Hole 418.

Overall coordination for the program is provided by the Johns Hopkins University Applied Physics Laboratory with assistance by a group of scientists from government and private organizations including the Science Applications International Corporation (SAIC), the Naval Oceanographic Research and Development Activity (NORDA), Woods Hole Oceanographic Institution (WHOI) and the Scripps Institution of Oceanography (SIO).

Fiscal Year 1988 tasks include the purchase (from CGG of France) of the multinode and multicomponent broad band seismograph for emplacement in the seafloor (WHOI/MIT), design and construction of the bottom control unit for the array (WHOI), the updating of the electronics, timing and recording capacity of available ocean bottom seismographs (SIO and NORDA), updating the VEKA vertical hydrophone array (NORDA), and the preparation of a Remotely Operated Vehicle (ROV) for borehole re-entry (SIO).

The Ocean Drilling Program (ODP) and the Joint Oceanographic Institutions, Inc. (JOI) have supported related research objectives and planning for future experiments. The JOI U.S. Science Advisory Committee (USSAC) sponsored a workshop in 1987 entitled *Science Opportunities created by wireline re-entry of deepsea boreholes* and the USSAC Program Plan calls for the development of a wireline re-entry system for general seafloor use during the next three years. Borehole seismometry and sub-seafloor instrumentation are the subjects of another JOI-USSAC workshop scheduled for April 1988, *Permanent Ocean Bottom Geophysical Observatories.*

This project is made possible by the successes of the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Project (ODP) which have been sponsored by the National Science Foundation and several non U.S. partners. This research follows directly from the earlier DSDP studies in the Atlantic in a re-entry and recovery from Hole 395A in 1981 (Leg 78B) and in the Pacific at Hole 581 (leg 88, 1982) and the later Ngendei Experiment (Hole 595B during Leg 91 in 1983). These earlier experiments were funded by the Defense Advanced Research Projects Agency (DARPA) and this agency is providing the major share of the funds for this experiment. The development of reliable and affordable deep sea maneuvering systems that can operate from conventional research ships will extend the scientific yield from the seafloor boreholes. The ODP regularly exploits the holes drilled in the seafloor from the D/V JOIDES Resolution through petrological, geochemical and paleomagnetic studies of the samples and logging, electrical and seismic studies of the holes. These decades of studies recognize that the existing boreholes are a scientific legacy that are available for further exploitation. Studies such as LFASE are required as ocean scientists seek to exploit seafloor measurements in the global study of the Earth through the deployment of long term observatories.

The first actual tests of a re-entry system were carried out in France using the submersible Nautile in 1986. The French approach used a special frame (NADIA - Navette de Diagraphie) fitted with a logging winch and 1,000 m of cable which was docked in the re-entry cone by the submersible. The next step in the French program will be to re-enter DSDP Hole 396B in the Atlantic. Scientists at the Pacific Geoscience Centre in Canada intend to use an advanced ROV for re-entry with a NADIA-like system. At a later stage, the Canada group would use the ROV to guide instruments, suspended from a surface ship, into a re-entry cone. This is very similar to the approach being taken in LFASE.